Modelling the Effects of Fiscal Policy Choices on Debt, Crises and Recovery for Small Open Economies

Hatfield, Richard

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A Thesis submitted for the degree of Doctor of Philosophy

Department of Economics
University of Bath

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Contents

Declaration

This work was done wholly or mainly while in candidature for a research degree at this University. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated. Where I have consulted the published work of others, this is always clearly attributed. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work. I have acknowledged all main sources of help. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Candidate's Signature 

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Dedication

I dedicate this work to my wife, Kathryn and to my late parents, Barrie and Doreen, who sadly passed away during this journey.

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I would like to express my sincere gratitude to:

- My supervisors, Professor Maik Schneider, Professor Chris Martin and Dr Vito Polito for their undying patience and support.
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Summary

Crises have littered human history with serious consequences for both the country and its people. The 2008 Great Recession and Asian Financial Crisis are exemplars of such serious economic and social damage that took many years to recover. Debt default is one of the main contributors to crises and has long lasting effects on the economy. This thesis illustrates a macroeconomic model for Open Economies that can simulate a range of economic policy settings and strategies for managing debt in a crisis. The simulations provide insight into the possible outcomes for small and medium sized economies that may aid policy development to prevent and mitigate the effects of a crisis. Moreover, this thesis explores the economic and political ideologies and how they have influenced macroeconomic policy development with potentially negative outcomes for the least able in society. Rather than use one economic ideology, the underpinning analysis draws on many different economic schools to interpret what is a neoclassical Real Business Cycle style model with many extensions and adaptations. This model and its software system is adaptable to a wide range of country settings that can support the evaluation of possible economic policy, debt and crisis management strategies. The underlying system is extensible permitting the exploration of new or alternate fiscal policy options and strategies.

Chapter 1

A Tale of Two Cities

1.1 Introduction

Now as I conclude this work in July 2020, with one of the most severe human public health and economic crisis in living memory brings me to recollect a book from my teens, the first paragraph:

> "It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us, we were all going direct to Heaven, we were all going direct the other way – in short, the period was so far like the present period, that some of its noisiest authorities insisted on its being received, for good or for evil, in the superlative degree of comparison only." - *Charles Dickens, Tale of Two Cities*.

So why would I start with something political, moral and a commentary on the social condition for an economics work?

Without context of the political landscape and social conditions we often find ourselves when in a crisis, one cannot describe, characterise or make morally sound economic policy arguments or insights into crises. They tend to have a disproportionate effect on society although such crises tend to be a consequence of mixed capitalist economies. Income and wealth differentials develop across the socio-economic spectrum depending fiscal and monetary policies responses to a crisis (Mitchell, Wray and Watts, 2019; Dosi et al., 2013; Blyth, 2013). Therefore it is important to understand the dynamics and consequences to households, firms, the government and foreign investors under different policy settings and fiscal response strategies.

Crises are notoriously hard to forecast with any certainty in either timing and impact (Eicher et al., 2019). The 2008 crisis is an examples where OECD (Organisation for Economic Co-operation and Development) predictions indicate that there will be volatility in the markets leading to a subdued economy, however they were more concerned with too much expansionary activity inducing inflation (OECD, 2008). Of course, the Lucas critique has some bearing

here, if one is able to forecast a crisis and in some-way prevent or mitigate it, by the nature of preventing or mitigating a crisis might make government less prepared for the next. If government and other actors took a risk management approach, then they would build in levels of resilience, have crises plans in place and would exercise them regularly. However human behaviour eventually reduces the effort and resources put into such measures limiting their effectiveness. One only has to look at many governments being caught out by Covid-19 even though with the last twenty years they put in place resources and plans as a result of SARS and MERS epidemics.

Another aspect is fundamental uncertainty and the diverse treatment of uncertainty by the different schools of economic thought (Dow, 2015). The important aspect of uncertainty in terms of a crisis is that time, the depth of the crisis, the spillover effects and the tail that eventuates makes it difficult to 'insure' against. If governments and NGO's (Non-government organisations) are unable to forecast crises then how can governments prepare and respond to them. We seek to analyse the effects of different policies and strategies on an open economy that may be in place *ex-ante* or *ex-post* particularly in economies where there are restrictions [1] on credit by either the imposition of conditions by powerful actors or by treaty.

1.2 Question and Objectives

This naturally brings us to this work's fundamental motivating question:

> Is it possible to create a flexible parsimonious macroeconomic computer simulation model that can illustrate the frequency, types and time-paths of various financial crises in an open economy with credit restrictions?

Our motivation for the question is that history tends to repeat itself, or doing the same things and expecting a different outcome depending on one's interpretation and perspective. Economic, as opposed to political, crises have littered history in all parts of the world. Although many economic crises have their foundation the political landscape, they can have a fundamental step change in both the economic and social order. The 2008 crisis, whether it be from the regulatory framework or corruption or by some external influence, had a significant differential impact on countries and socio-economic groups that has left both economic and social scars (Chambers and Kopstein, 2001; Arulampalam, Gregg and Gregory, 2008; Kapuvari, 2011). Moreover, the 2020 pandemic and response has a much more polarised policy and strategy response across several nations (Gräbner, Heimberger and Kapeller, 2020). It may be that the polarisation became more evident once the crisis impacts both the general populous and government resulting in events become ever more amplified. Therefore if we can in some way inform on the range of options open to those that set macroeconomic policy.

[1] By restriction we mean that part or all of the public debt issuance is in a foreign currency or, as in a monetary union, the government does not have full control over its monetary policy or a situation where an NGO has imposed conditions that limit the level of public debt and requiring the government to operate within certain fiscal policy bounds.

What we are trying to find is a generally accepted foundational neoclassical model that is not complicated by many of the New Keynesian frictions that can simulate crises with different fiscal policy settings, strategies and restrictions. Keeping the foundation simple permits the extensions to induce model behaviours akin to crises such as sudden stops, double dips, rippling effects though an economy using quite simple rules based decision making that most policy makers could easily comprehend. Therefore our objective of this work to address the question is:

> To develop, construct and demonstrate a understandable, flexible model and its supporting computational environment that simulates the unfolding of different types of crises with a wide range of fiscal policy settings and government strategies for bailouts and debt management[2].

To this end, this work simulates and discusses macroeconomic crises in the context of different philosophical economic schools, social and political norms to identify a range of challenges in responding to a crisis. We take a neoclassical style (Real Business Cycle) macroeconomic model from the seminal works of Eaton, Gersovitz and Stiglitz (1986); Schmitt-Grohé and Uribe (2016a); Na et al. (2014) and extend it well beyond the original intent. The extensions include both private and public sector debt, crisis sequencing, fiscal policy rules and, bailout and defaulting strategies. Furthermore, although the core model founds in the neoclassical tradition, we discuss a range of different economic schools, ideologies and their interpretations and possible alternative conclusions. Therefore, the reader should expect challenges to the neoclassical theoretical foundations during this discourse.

We interpret the different simulations and policy scenarios using theories from different economic schools. This provides us with a range of insights into policy outcomes ensuring that we account for the assumptions. Important, and often neglected is the discussion on the assumptions. We discuss the assumptions and evidence in these first two chapters and apply the interpretations to the model in Chapter 3 though to Chapter 8. The model is not an end in itself and makes no claim as such. No model, or ideology holds the higher ground, or the answers to problems and to claim so is to almost has a religious undertone to it (Stiglitz, 2018)[3]. Rather than make direct policy recommendations, we seek to show some ideas and insights founded on the assumptions that will require interpretation by policy makers in the particular economic, social and political context that they find themselves in.

An important aspect of this model is its flexibility to turn on and off policies and strategies, use different calibrations, regardless of their stability. We create scenarios from a range of policy and strategy combinations that we run a stochastic simulation against. Fundamental and an important difference to many macro models is that it includes private sector debt independent of public sector debt. To fund these debts we use a foreign 'banker' that has limitless funds to invest and can tolerate crises. The 'banker' that provides debt in a foreign currency avoids

[2]Throughout the work, we will refer to the combination of fiscal policy setting and strategies as a scenario that we run in simulation to identify and classify crises events.

[3]Some of the Neoclassical papers that we cite almost border on a religious ideology with the theories and assumptions that form part of the belief system

to the topic of money creation that we will discuss later. Furthermore, treating the country as 'small', although small is relative to the world economy, that is it is a price taker. Further, small can mean a country that does not have control over the currency it issues debt in or its banking system. Small, in this context, means there are constraints, means that world market prices for goods and finance rule somewhat simplifying the model.

1.3 Contextualising Economic Ideology in Crises

Turning back to the Dickens quote, there are some important aspects that we need to draw out in context of crises and the circumstances that people find themselves in. It presents us with a set of paradoxes and dualities just as applicable now as they were when Dickens wrote the work. In the 2020 pandemic, already we can see that it is the 'best of times' for some and the 'worst of times' for others as it unfolds. One only need to look back at the 2007-8 crisis and the response by governments following certain economic ideologies and the consequences.

If we take the UK[4] for example, the 2008 crisis and the response by both fiscal and monetary authorities lead to a widening wealth gap across deciles (Gagnon et al., 2019). A consequence was and is the considerable increase in financial asset wealth largely from the portfolio balance channel (Joyce et al., 2011; Shah et al., 2019). Net wealth remained static for the lowest wealth deciles whereas growth rates in the upper wealth deciles grew at rates 40% to 140% in 10 years well in excess of long run capital returns (Gagnon et al., 2019). Moreover, low income groups saw real wages decrease from 2008 onwards in many developed economies. Bailouts, in these cases, did not compensate low income groups for the substantial losses in both wealth and income, whereas the wealthy were compensated for the losses. Therefore, who is targetted with a bailout and who are the eventual beneficiaries is an important question often ignored by the neo-liberal and neoclassical ideologies.

This leads to the second point, "...age of wisdom and age of foolishness...". For parsimony, homogeneous agents are the core tenor of most macroeconomic models, although there are some with limited heterogeneity. Such models are both tractable and solvable mathematically. We can characterise the models in this work being from that tradition. If one was to develop policy from those models then one falls into the trap that we illustrate before. This is ignoring the asymmetric distributional factors so evident from the 2008 crisis. Then to repeat it would be foolishness itself. As in Colander and Freedman (2018) and Fullbrook and Morgan (2020), this is a criticism not only for classical economic schools, it is for all schools, Therefore any recommendation needs to be tempered with caution, particularly when making policy insights for crisis events.

This work will rail against some of the received wisdom[5] of current mainstream macroeconomic ideology in favour of other philosophies and ideologies that might give greater insight. Nevertheless, those that use such 'received wisdom' without qualifying it, in some cases to

[4] Although the UK has a sovereign debt currency issuing ability, the government at the time chose to act as if public debt was constrained by the government choosing to follow the neoclassical specification, namely the intertemporal budget constraint that imposes Ricardian Equivalence resulting in a policy of Austerity post 2010.

[5] 'noisiest authorities insisted on it being received....'

further their own political or social ends need to be questioned and held to account. For example, the received wisdom of 2010 UK election was that high levels of government debt is bad, we need to get the deficit down and blaming it on the last government for the government debt 'crisis'. The policy response, government austerity, largely supported by the 'established' economics community as the 'appropriate' policy response.

> "It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so." - *Attributed to Mark Twain*

Such ideology permeated many of the southern EU nations enforced by IMF, ECB and the EC (Reinhart, Rogoff and Savastano, 2003; Reinhart and Rogoff, 2011a). As Blyth (2013) illustrates, the whole concept of austerity and austerity politics is founded on ideas from current classical economics. These have and continue to be carried though into modern variations with significant social and economic cost in the long run. The impacts are severe on poorer, less resilient households and communities. Compounding factor is the aftermath of the 2008 financial crisis that has left many countries and communities compromised and unable to withstand another crisis (Arestis and Pelagidis, 2010).

This 'conservative' neoclassical economic view mixed well with the politics of 'conservative' neo-liberalism that denominates much of European and American politics. This continues to have a significant impact on Southern European countries and the poor in many others within Europe. Moreover, the social cost of such policies may be incalculable in economic terms as well as the breeding ground for right leaning authoritarian actors to take advantage (Micocci and Di Mario, 2017). Be warned, democracy, the underpinning political system that most economists subscribe to, can easily be threatened (Snyder, 2017). There are political implications to any economic policy and there is political environment that macroeconomic policy must exists in. One can invoke the extremes in the other. As in Dickens, economic despair often leads to political action that changes the political order though non-democratic means.

It is important to understand where these ideas come from, we will use a couple by way of example. Principally, the inter-temporal budget constraint of governments, banks only intermediate money, Ricardian equivalence, expansionary fiscal austerity, that fiscal expansion creates inflation and crowds out private investment, are all theories that are both taught to undergraduates and postgraduate as received wisdom. Crises bring into sharp focus these theories and if or when they actually apply. If governments are to act then they need to comprehend the real constraints on fiscal investment and expenditures. In answering these questions, one needs to look at the different economic schools. Austrians are of the mind of that markets will self correct. Keynesians are for fiscal intervention to make up for the deficit in labour utilisation, thus create demand and hence investment. This contrast leaves much space for modelling to compare different policies and strategies before and during a crisis.

How does a government fund the response to a crisis? The classical view is by borrowing from the private and foreign sectors, normally bonds. Alternatively, central bank can credit the public accounts with funds, it can just spend it, then settle using an 'overdraft' with the central bank (Wray, 2019; Kelton, 2020). However government may be restricted by lenders to

borrow in foreign terms (regardless of if it is domestic lenders). Both the classical and foreign terms borrowing impose an inter-temporal budget constraint on the government. Examples of this are many middle to low income countries and any country in the EUROZONE. This restriction means that fiscal expansion is constrained by the debt service levels the economy can entertain. However, borrowing in domestic currency or foreign investors buy debt in domestic currency then government can adopt both fiscal and monetary expansion either via the central bank and/or commercial banks. This changes the dynamic of the economy where government spends to stimulate and taxes to moderate rather than for funding of government[6](Kelton, 2020). Countries such as the USA, UK, Australia that issue debt in their own currency that is widely accepted can adopt that strategy. As Japan demonstrates, high levels of debt are a false equivalence to signs of policy mismanagement and economic disaster when debt is in ones own currency.

With regard to banking and the way that they fund lending, including to the government, has a material impact on the way that the economy behaves. The loanable funds model or quantity theory then banks would need the deposits ***before*** lending, whereas credit theory states deposits are as a ***result*** of lending (Faure, 2020). They are diametrically opposed which bring into question under what circumstance do these different theories apply. Faure and Gersbach (2017) state equivalency between loanable funds and credit money creation under some extreme circumstances, that is no default and no failure, making the argument rather obtuse. in Contrast, the BoE (McLeay, Radia and Thomas, 2014) with other central banks such as Bundesbank, Norge Bank and even the Federal Reserve state that banks create and destroy bank money during the lending and repayment process. This contradiction created a furore from neoclassical theorists on what is seen by central and commercial banks as normal banking practice. It is neoclassical economic thinking that is out of step with the real world, *what they know for sure is just ain't so*.

Loanable funds/quantity theory can easily be incorporated into a traditional equilibrium model as many do including Gertler and Kiyotaki (2015) and Gertler and Karadi (2015) that make provision for defaulting. These models somewhat unrealistically 'engineer' a fraud to create the default rather than consider the feedback loop between continued profits and the desire for more. McLeay, Radia and Thomas (2014) illustrates that bankers have two core preferences, how much revenue or profit they wish to make and how much risk they are willing to take on. These desires modify with time and how successful they are normally taking on increasing risk to counteract falling profits. This falls into the Minsky (1992) that we discuss later. The level of risk perceived by the banker determines that capital requirement of a bank and not the level of reserves so often put forward in the neoclassical interpretation.

So why is this important in regard to government default? By construction and legislative edict, government that can issue debt in their own currency have access to domestic commercial banks and either directly or indirectly, the central bank. Moreover, the central bank can control

[6]Where there is enforcement of contracts, rule of law and a stable government that honours its debts, then banks can lend to the government and create a safe revenue stream that is easily convertible to reserves or liquidity. The reason that government enter into this arrangement is that many jurisdictions do not allow central banks to lend directly to the government. This imposes an intermediary step, commercial banks.

the yield on government debt by buying or selling it as a part of open market operations as QE (Quantitative Easing) has demonstrated over the 10 years from the crisis (Martin and Milas, 2012; Christensen and Rudebusch, 2012; Joyce et al., 2012, 2011). Banks carry government debt on their balance sheets as assets to ensure that it has sufficiently liquid assets that it can trade for reserves whilst still receiving a (small) return. Unfortunately, the financial crisis demonstrates how easy it is to increasingly go for more risky assets to increase profitability believing those assets were 'as safe as houses'.

So this brings us to why we needed to cover this first? How is it relevant to a work on Crises and debt? Context, the epistemological foundations are provide frame that we assess any analysis and this work because as Santayana (1905) states

> "The line between what is known scientifically and what has to be assumed in order to support knowledge is impossible to draw"

and is particularly so for a social science. As we have already indicated, our work and the analysis herein draws on mainly Neoclassical RBC and New Keynesian, Keynesian and Post-Keynesian and Modern Monetary Theory ideas, theories and arguments. Furthermore, we will touch on some Austrian, principally Hayekian and Schumpeterian thinking, draw a little from Marx about labour and Minsky on fundamental instability.

One's frame of reference, ideology and theories are important as they drive the assumptions that one makes. A pluralist view does not discount any particular view on the basis of school. We does this on the basis that no particular school has all the answers. Rather, we conduct our discussion on the basis of comparing different schools and drawing out conclusions. An example is a fundamental difference between Neoclassical and Post-Keynesian, namely Say's Law and the law of Effective Aggregate Demand that raise the questions: do saving drive investment or are savings a result of investment and of course, loans from deposits or loans create deposits. in search of possible explanations, we draw from many sources beyond the traditional viewpoints.

1.4 Debt, Risk and Uncertainty

Until 2008 crises, private debt, the private sector flow credit, leveraging and deleveraging was not on the 'radar' of many neoclassical academic and professional economists, rather the focus was more on sovereign or public debt. Still some remain in denial, maintaining positions and theories that now seem untenable as we shall illustrate later. This was particularly evident in the commentary by media, politicians and academic economists. Most now recognise that private debt dynamics was one of the major drivers of the 2008, then it might be important to consider it in any evaluation.

How did this come about? It seems the lessons from the 1929 crash were largely forgotten with relaxation of regulation and weakening of the protective institutions. This leads to real threat of inflated asset prices and due the interconnected nature of banks and financial institutions, the

wholesale underestimation of risk and a complete lack of understand of the difference between fundamental uncertainty and risk (Strahan, 2013; Skidelsky, 2018; Longstaff et al., 2011; Ang and Longstaff, 2013). The recent financial crisis triggered largely by a number of failures in the the financial sector has left many nations with large deficits, elevated levels of debt, low growth and central bank balance sheets inflated with a range of potentially toxic assets. This necessitates that consideration of both private and public debt in the assessment of sovereign credit worthiness, hence the risk premium (Arteta and Hale, 2008).

Continuing the discussion on the fundamental dichotomy between classical, neoclassical schools and that of Post-Keynesian, Kelechian, MMT in the way that banks operate. We already noted above this difference with the ability of banks to create money. Furthermore and in the words of Minsky, the Paradox of Stability, where the perception of stability of the financial system possibly is an indicator of how actually unstable it is (Minsky, 1992; Mehrling, 1999). The feeling of stability and the need to profit drive the need to take increasing risks whilst being unaware of the consequences at both a corporate and system level. The question is does savings drive investment or investment drive savings? If banks create the money to lend to firms to invest, then the result of that investment is deposits and savings. If banks can create all of the money that they need, why do they need to issue bonds and particularly to foreign investors[7] considering this puts them possibly under exchange rate risk?

The main reasons are, firstly, to balance up the maturity mismatch that exists between deposits and equity when considering most of a bank's asset portfolio is illiquid loans. Deposits can be called on without notice whereas a bank foreclosing or liquidating is somewhat more problematic. Secondly, using short term money market borrowing to fund liquidity exposes the bank to re-issuance risk as Northern Rock Bank experienced in the 2007/8 crisis. A proportion of liquidity comes from the Central Bank borrowing, however much comes from the closed reserves market that trades liquidity on a day to day basis. When the country does not have sufficient financial resources to fund bank borrowing then it needs to turn to overseas markets and if the domestic currency is not 'valued' by foreign investors then they will need to borrow in a foreign currency and carry exchange rate risk themselves.

As to speculators. Both the 1929 and 2008 crash, as well as the Bubble Company, Tulip mania, South Sea bubble) were rooted in so called investment lending using margin accounts and other similar borrowing to fund financial asset purchases. This creates the perfect storm both both the investor and the financial institutions providing funds without it being obvious at the time. Effectively, creating a market wide Ponzi scheme that runs out steam. What is seen as stability is the foundations of instability (Minsky, 1992).

Here we need to discuss some accounting basics. Debt is a stock that is as result of a contract between parties that exchanges cash-flows. That contract sets out obligations in the form of payment schedules and the recourse on default paths. Those cash-flows are in the form of *credit flow* being extended by the lender to the borrower and for the borrower to repay the

[7]Many of the Banks in developed and high income developing countries borrow from outside the country, Example, over 60% of New Zealand bank borrowing is from overseas resources both in domestic and foreign currency (Reserve Bank of New Zealand).

borrowings with normally some form of usury at some future dates. Therefore, in GAAP[8] the borrower must count all debt as a liability and the lender counts it as an asset that is subject to revaluation[9]. Although goods exchange may result from a contract and may provide security for the honouring of the contract they do not form the contract themselves. The lender can sell debt and the borrower can swap debt cash-flows. Normally, corporate and sovereign debt is in the form of term specified bonds and may be part of a portfolio of debt issuance with different time-frames for terms and settlements. The fundamental issue for banks that hold nearly all their assets as financial assets is that they are subject to market fluctuations though mark to market and loan book delinquency. Lehmans is a case in point. This leads us into the discussion private debt.

1.4.1 Private Debt

Bankers make lending decisions on what they forecast the market to be in the future to determine the level of risk they wish to take on and the profit they wish to make. Three main categories for private lending; to households, that is mortgages, credit cards for example, to firms to fund both cash-flow and investment, and to investors (we will call the speculators). With households and firms, one would expect the flow of credit to be stable, that is the overall leveraging does not change much. When credit flow is accelerating, whether it be for mortgages or for speculation, then that represents a systemic risk to households, business and the financial infrastructure (Miller and Stiglitz, 2010; Arteta and Hale, 2008). As we explain later, such a breakdown will lead to difficulties in the public sector (Gennaioli, Martin and Rossi, 2014; Arellano and Kocherlakota, 2014).

Continuing on with the theme that banks create money to lend, therefore they destroy it when they are repaid, we need to consider what happens to consumption in both cases. if lending criteria is relaxed, then consumption will increase, such sustained consumption will drive firms to invest and to invest they borrow. Hence banks have a two fold positive effect on the economy when lending. This was part of motivation for QE to encourage banks to lend[10]. Likewise, if bankers forecast suppression in the economy, thus increasing default rates, then they will tighten credit flow, possibly eliminating it altogether. Banks will operate a 'sinking lid' on their loan books, forcing consumers and firms to deleverage, that then reduces consumption and investment (Eggertsson and Krugman, 2012). Banks effectively amplify the cycles rather than act as a smoothing device in the economy though. This is either lending over-leveraging or by debt deleveraging that leads to inflation (either sector or nationally) or suppression of consumption either by deflationary pressures or funds being devoted to debt repayment. The recessionary sinking lid that banks operate mean that one cannot equivalence debt repayment to saving, a common mistake made by many economists.

[8] Generally Accept Accounting Procedures

[9] Revaluation occurs with fixed assets in the form of depreciation and financial assets in the form of mark to market pricing

[10] We note that QE is a credit supply ideology rather than a demand ideology. The lack of appetite for credit from both firms and households in a recession though uncertainty would limit the effect of QE on the household and production sector, therefore encouraging the more speculative 'investment' though stock markets.

Hence, bank crises tend to be more prevalent than Sovereign debt crises (see Chapter 2). Furthermore, the fortunes of households, firms and domestic banks are so heavily intertwined that such events as mass defaulting in the household sector results in banks defaulting on their borrowings. Therefore, bank crises are household and firm crises as well. One only has to look at the 2008 financial crisis to see those interdependences. If one takes into account small open economies that undertake bank funding using overseas resources, then the exposure is much greater, as it affects the terms of trade, than say an economy that borrows in its own currency (Benigno and Romei, 2014). This leads us to conclude that one can model simply the a homogeneous representative household and a foreign lender and largely ignore the role of the bank in the lending and defaulting mechanism.

1.4.2 Public Debt

We will categorise two groups of countries, ones that issue debt in their own currency where such issuances are rarely under-subscribed and those that issue currency in another country or currency union's currency. Except for the EU, most of the OECD countries forming the backbone of the World Bank high income category largely fall into the first group. However, it is rarely one or the other, many middle income nations have a mixture of domestic and foreign denominated debt (Bonizzi, Kaltenbrunner and Michell, 2019). As discussed, there is a significant ideological difference here over the treatment of sovereign debt between the neoclassical school and that of Post-Keynesian with an MMT flavour[11]. The conceptual difference is that classical thinking is that the level of debt is constrained by the discounted future cashflows taking to account growth and interest. Therefore, if there is debt, then the discounted future primary surpluses must less the interest must be equivalent to that debt. Tax revenues must exceed expenditures, if debt becomes too large, then tax revenues need to increase and/or expenditures decrease that drives the policy of austerity. The mantra, the government needs to behave as a household or firm would do ignores that MMT view that governments create the money to spend in the first place with the need for bond issuance is to create a safe asset that provides liquidity and stability whilst making a small return.

PK/MMT world would generally agree that the neoclassical stance would be applicable to a country that either issues debt is a foreign currency or pegs their exchange rate (Arellano and Kocherlakota, 2014; Connors and Mitchell, 2017). We can therefore safely draw that most developing medium and low income countries would have to conform to this rule as they issue debt in foreign terms or they currency peg such as Argentina in the late 1990's or some of the Asian countries prior to the Asian crisis. As all of the European Eurozone countries are effectively using a foreign currency with the EURO for fiscal borrowing they are all constrained in a similar way[12]. This implies that there is a limit to the amount of debt that foreign investors are willing to entertain (Bi, 2012; Kumar and Baldacci, 2010; Assibey-Yeboah, Mallick and Mohsin, 2016). Moreover, economic NGO's[13] will only entertain funding, support and interventions

[11] Not something that some Post-Keynesians would subscribe to!

[12] The ECB has monetary control over the EURO, not the central banks of each nation state. Therefore the central banks cannot create money that the government spends

[13] Economic NGO's include World Bank, IMF, ECB

with a fiscal responsibility pact that includes controlling the level of public debt.

Another characteristic is that any public debt issued in domestic currency is normally for the domestic economy's consumption and not foreign investors (Cantore et al., 2017; D'Erasmo and Mendoza, 2016a). There is is a case that governments may choose to default on the domestic debt in deference to the foreign issued debt. As in D'Erasmo and Mendoza (2016b), there may be a optimal method of sovereign default either by creating inflation or haircutting or both. The important aspect is debt is *constrained* sometimes by legislation or by treaty (Commission, 2015).

This leads us to a deep neoclassical form of constraint is tax revenue and controversially, is the Laffer curve (Laffer, 2004). This is reliant on taxation being on the supply and not on demand[14] and that there is no incentive to work when all labour wage is consumed in tax. This implies there is a peak or optimal level of taxation based on preferences and that a situation can exist where higher taxation leads to lower tax revenues. This is somewhat problematic in that it assumes a universal tax rate for all labour, that high-income persons would vary their labour input according to the tax rate. Even at rates in the 70-90% that we have seen historically high income individuals do not reduce their labour input. However, low paid workers are more likely to lower their productivity and increase hours according maintain income.

This brings into question the philosophy behind the Laffer curve (and others of a similar nature) as fiscal taxation policy (Mirowski, 1982). Yes, high taxation on wealthy individuals may render avoidance. However, the evidence does not support that view as tax aggressive tax avoidance can attract unwanted attention of tax authorities exposing them to the risk being charged with evasion with the complexity of tax law. Therefore the limitation for an economy that *requires* tax revenue to fund expenditure and debt service must be somewhere else. Furthermore, endlessly increasing taxation might have significant socio-political effects that are undesirable to a government. If tax revenues prove to be insufficient, then governments may seek to haircut part of the debt and enter into Paris Club Negotiations (Yue, 2010; Haldane et al., 2003; Das, Papaioannou and Trebesch, 2012). As we will discuss in Chapter 7 and Chapter 8, it is in the interests of both borrower or lender to renegotiate rather than face sanctions and or loose the entire investment.

The classical view is that the economy's borrowing is constrained by the inter-temporal government budget constraint regardless of how the debt is denominated, however this is no a view shared with other schools. Those countries that issue debt in their own terms and have no under-subscription or special terms needed for their debt. We will use QE as the example to demonstrate the point particularly as it is used in response to a crisis (Joyce et al., 2012). QE, the central bank buys sovereign bonds from financial institutions in exchange for reserves. Hence the price of those bonds increases, the FI (financial Institution) transforms an asset into a more liquid asset and the central bank increases expands the balance sheet equally. The government sells bonds to financial institutions. The process of buying is that the financial institution credits the governments account (a liability to the bank) and creates the asset of the bonds on their books, similar to the way that they create a loan, therefore the bank expands its balance sheet

[14] consumption taxes are on the demand side, same as payroll taxes to the employer

and so does the government with a liability (the bonds) and an asset (the payment). Then the central bank can swap those bonds for reserves as before. When the bonds mature, the government buys back those bonds by using its treasury account at the central bank. As Kelton (2020) explains, the government does not even need to issue bonds, it could, if unrestricted by legislation, just run an overdraft with the central bank. This is the MMT view of a highly integrated, sovereign currency debt issuer that is not available to all countries. Effectively the central bank controls the yields on bonds by its open market operations and the fiscal authority, inflation as we will discuss next.

Following the Post-Keynesian argument, there is however some limitations and they come from labour, inflation and investment.When effective aggregate demand nears aggregate supply (either across all sectors or within a sector or sectors) then labour wage may start to increase as does inflation. When effective demand exceeds current supply capacity of the economy then inflationary pressures will raise prices, hence inflation. If government expenditures are creating that demand, then government is driving inflation, hence government needs to ensure that it does not create excessive demand either across the economy or within a sector or sectors. An important note here is that banks, though lending policy, can create a similar effect in asset prices such as housing, commodities and equity markets that we have seen in recent history. Furthermore, in a open economy, that demand may also be satisfied by importing pushing demand for the local currency downwards creating import inflation that may affect domestic production. When aggregate demand is deficient, then there is little effect on prices, as Keynes states, prices are sticky (largely governed by cost of production) and will only gradually deflate, if at all, and there will be unemployment.

So how can fiscal control inflation? The MMT view is that taxation and bond issuance, that takes money out of the economy can regulate inflation. Taxation is not used to fund government expenditures or debt service, rather its used for regulating inflation in one or more sectors and perform a rebalancing inequality and alter behaviour. The purpose of bond is is to provide a safe asset for the economy and to assist in regulating interest rates (Kelton, 2020; Connors and Mitchell, 2017). There are many Post-Keynsians that do not agree with the premise in MMT levelling some criticisms on some areas lack of formalism in such areas as the role of taxation and bond issuance. Nevertheless, Colacchio and Forges Davanzati (2020) explores a more formal framework and the establishment of the idea of government as the employer of last resort, the role of taxation and debt management that combines more favourably monetary and fiscal policy beyond that of prior authors.

Regardless of some of the specifics of operation, there is a considerable dichotomy between the neoclassical and MMT/Post-Keynsian schools on the ability of governments to respond in a crisis and the level of 'mopping up' to 'balance the budget' that may be necessary. This important difference leads to how politicians respond to a crisis and then how they seek to straighten out the economy. At one end, high public debt is a 'bad' that needs to be corrected with reduced government spending. At the other end, it is a necessity of a modern economy for government to focus should be more on employment and investment to enable recovery.

Vivid realisation of both of these is in the 2010 response by the UK government with austerity

and that of the 1933 US government of expansionism. That brings us to the role of government, does it just look after itself, the self interest rational agent government or does it work to address the socio-economic conditions of the household? This is fundamental to the philosophical debate between the neoclassical school and the Post-Keynesian schools. However, one aspect that neoclassical and many Post-Keynsians can agree on is that when government have little sovereignty over the currency that their debt is issued in the the choice is between an austere fiscal policy or default or both.

1.5 Crises and responses

First, some definitions and questions about what is a crisis, classifications, the possible causes, consequences and the mechanisms. If we start by defining a crisis by its characteristics, the first is that they are rare, infrequent events there we can distinguish them from normal cyclical macroeconomic behaviour (Reinhart and Rogoff, 2011b) and as such, are largely unforeseen, unplanned, tend to sudden and that suddenness tends to cause it to be transmitted throughout the economy's sectors quickly. They have a surprise element, as we have already discussed with the OECD and IMF making them almost impossible to forecast with any accuracy. They are situations where falling incomes and/or collapsing asset values, real or financial, that result in distress in the household and/or firms (including financial institutions) that distresses any debt they may hold. This distress flows though to the banking sector in degrading balance sheet though non-performing loans and asset value write-downs though mark-to-market accounting principles. Furthermore, they may have substantial calls on liquidity. They will seek to protect its balance sheets by reducing credit supply putting both firms and households under further distress (Laeven and Valencia, 2018). Another aspect is that banks will seek to liquidate assets into a potentially flooded asset markets, particularly if those assets are a result of foreclosure. Thus they force a revaluation of assets downwards as they attempt to protect themselves making the situation much worse (Reinhart and Rogoff, 2011b). This is how a crisis can unfold, it rather depends on the causes.

An excellent exposition on financial crises, including Keynes, Minsky and Shiller discussion on financial fragility, inherent instability and asset bubbles is in Detzer and Herr (2014). The former is reliant on fundamental uncertainty, the differential rates of return on money and capital and the difference between those that run business and the 'casino' stock market that leads into both Minsky's FIH (Minsky, 1992) and possibly Shiller's asset price bubbles(Shiller, 1999, 2002, 2015). Banks unique ability to create money inherently makes them unstable (Minsky, 1992). It goes that stability increases the demand for greater profits although capital returns may not be increasing, hence seeking out other assets then increase asset values (Schiller Bubble) that increase the motive to buy more and so on until, asset prices stop increasing, then it collapses. Either way, bank balance sheets end up in the situation we set out before.

When the banking sector forces deleveraging or there is a sudden stop in the economy (supply of credit dries up), then consumption ebbs. Households forced to deleverage either by defaulting or credit restrictions, will reduce consumption. The interaction between firms and and

households though consumption and the labour channels increases unemployment as firms feel the distress in funding passing that distress onto the household, that, with income reduction, reduces consumption. All of these amplifies the crisis and driving a crisis of confidence across all sectors. Private sector crises, particularly banking crises tend to step change downward in the economy establishing a new lower equilibrium and a lower growth rate (Laeven and Valencia, 2018). That effectively summarises the transmission though the economy.

One aspect of crises, particularly significant ones, is that they occur infrequently and their sequences tends to be subtly different. As we have already discussed, forecasting is problematic and history is forgotten. Taking the US great depression and its response, after some significant fiscal interventions and regulatory frameworks that were progressively eroded by successive governments as regulation was seen as more of in encumbrance rather than mechanism to maintain stability. A generation had past by and the lessons of history gradually faded into insignificance. Some early warnings where the 1987 Black Monday and the spill overs into the economy (Bogle, 2008) followed by the 2001 DotCOM bubble leading up to the the 2008 crisis.

However, some crises are 'exogenously'[15] generated, such as the current 2020 pandemic and the 1973 & 1975 oil crises. Still, these crises generate a economic fallout. The strength of the regulatory and social protection programmes largely governs how resilient the economy is, in particular the financial system in the face of declining balance sheets though asset revaluations and mark to market. Although the causes may be subtly different (or unsubtly so) the crisis itself either eventuates in the public or private sector taking some form of action to a potential default situation. This is our area of interest in this work.

A dimension to many of these crises is that the International Monetary Fund or other agencies step in with government bail out packages requiring reform, austerity and debt restructuring without crippling interest rates. Still, these are 'foreign lenders' of last resort do exact a premium over the international risk free rate albeit not at the rate private foreign investors may seek. These last resort leaders demand discipline by apply economic and political sanctions to ensure reform occurs[16]. We will treat the motivation of foreign government, NGO and private investors as largely with similar motivations when considering a crisis, namely, that is to be repaid.

The alternative to a government bailout package is default, exclusion, renegotiation and eventual return to credit markets. The problem with default is that both country and foreign investor suffers. Even with haircuts, default tends to deny the foreign investor of the funds to some considerable time, in many cases, years. Although, under the Paris Club, negotiations tend to result in some form of recompense, however international accounting and banking rules normally require defaulted debt to be effectively written off and any recompense accounted for at a later date. This implies that public or mass private default is seen as a cliff edge by foreign investors, one that they would rather avoid if at all possible. High debt has a long term impact on growth Reinhart and Rogoff (2010b). Therefore any recovery is slow as public

[15]The degree of exogeneity is somewhat questionable in the wider than economics context

[16]Many of these reforms have proved to be disastrous for both the economy and the population by destroying social safety nets, healthcare and privatising core government functions lead by political-economic ideologies.

and private debt deleveraging under the cloud of low growth though a lack of demand, high unemployment and no incentive to invest.

So what motivates governments to intervene in the private sector at potentially great risk to themselves? Taking the work Yue (2010), and De Paoli, Hoggarth and Saporta (2009), when an economy heads to or is in default then it may incur considerable loss through terms of trade, that is, foreign traders seek to limit their risk by limiting the trade credit and foreign exchange. Furthermore, limited access to credit that prevents consumption smoothing impacting domestic production. As previously stated, these reductions lead to reducing the tax base and need to reduce its own expenditures to continue to service debt.[17]. Such bailout may limit any mass default in the private sector, hence, limit the effects on tax revenues of a crisis by increasing public debt. Therefore a government may be motivated to protect tax revenues in the short term as the cliff edge of private default has material impact on their ability to service public debt. This brings us to the second question, the degree that a government is motivated to undertake bailout and its consequences. If the political consequences are dire, then this vulnerability may make them be compelled[18] to undertake one or more bailouts making them vulnerable public debt default.

Government feels the effects almost immediately with falling tax revenues and incomes from investments, whilst increasing debt to GDP ratios cause foreign investors to increase interest rates. The government may step in with funds to prevent mass default in the private sector, restore confidence and create some normally. These bailout funds come from public sector borrowing, hence transfer private sector mass default risk effectively to the government (Barth, Prabha and Yun, 2012; Acharya, Drechsler and Schnabl, 2014; Reinhart and Rogoff, 2010a). Effectively the equity owning part of the private sector privatises the profit and socialises the losses with any risk premium being exerted. In some cases, government reaches a debt limit and default in either or both private and public sectors eventuates. The experience of the European Countries is that the significant debt overhang results in normative austerity policies and the private sector seeking to deleverage. In some cases this results in social and political instability, again affecting foreign investors confidence and undermining the ability to recover.

Crises follow a typical pattern, that is there is normally a private debt crises that stems from banking practices in the country or the country's banks are exposed to mass asset write-downs that leads to both a government debt problem and a balance of payments problem (Kaminsky and Reinhart, 1999). The banking system, if it has had a long period of stability in the economy, has an amplifying effect on any recession though the households and banks deleveraging, reducing consumption that leads to a sharp decline in the economy. As we have discussed, the banking system can quite easily end up in a macro-level ponzi scheme though progressive institutional weakening that are put in place to minimise instability (Minsky, 1996). Although

[17]Governments may not be able to reduce expenditures in response to a sudden downturn. The parliamentary cycle determines that fiscal budgets are set in advance and deviation mid period is somewhat problematic as commitments for political and commercial reasons. It would be difficult for governments to quickly reduce the workforce, cancel spending commitments. Rather, a government will borrow to fund the shortfall with a view to correcting the short fall in subsequent budgetary periods.

[18]We use the term compelled in that the political and economic consequences of default in the public sector are too dire to be tenable. In the UK and USA, governments briefly looked over the cliff edge of mass private sector default

many authors identify events leading up to the crisis, we contrast that short term focus with a more longer term structural and institutional view.

From the 1980's the neo-liberal progressive weakening of regulation and institutions though the mantra of the Austrian School ideology of limiting government, 'free markets' and the market will self correct, allowed the banking and financial systems to become progressively unstable, creating asset bubbles in 1987, 2001 and the period leading up to 2007. The so called 'great moderation' set the stage for the 'Great Recession' and a major setback in income and growth in many nations. Some of which was from the policies that were either imposed or self imposed by government's political and economic ideology. The Neoclassical and Austrian schools have much to answer with regard to their policy recommendations without realising the unintended consequences that history has already taught us.

There are any number of ways that government may address a crisis in the broad spectra from benevolence to the government though to benevolence to some or all of the private sector; self protection, protection of investors in the government though to protecting the private sector or the household. Increasingly, many governments intervene in the private sector in an attempt to limit the effects of a mass default in a private debt crisis (Barth, Prabha and Yun, 2012; Acharya, Drechsler and Schnabl, 2014). These interventions necessitate government providing emergency funds (bailouts) to the private sector, in various guises[19], necessitating an increase public borrowing. Importantly, this leaves the country vulnerable to future downturns (Cantore et al., 2017). Many countries in this position resort to severe austerity measures in an attempt to reduce the government debt, albeit with limited success.

This paper seeks to explain by constructing a theoretical model of a private sector debt crises spread to the public sector and long term consequences for fiscal policy. Furthermore, this model seeks to explain how the public sector may be forced into bailing out the private sector when public debt is high and a default in the private sector may result in the demise of public sector debt.

1.5.1 Vulnerability to Default

The economy's vulnerability to default is quite simple, a private or public sector default constraints the flow of credit to fund household consumption, firm investment or government expenditures and investment. US 1929 crash, 1990's Asian financial and 2007/8 crisis illustrate the profound effects of default across both public and private sector. The options available to a sovereign debt country and those that rely on debt in foreign terms is striking, depending on the macroeconomic philosophy. We will take the economies that depend on debt in foreign terms.

We take two cases, high public and low public debt before a crisis emerges. High public debt would attract high servicing costs and represent a significant components of the total fiscal budget. Government would be aware that if mass default occurs in the private sector then

[19]Examples include equity injections into banks and insurance companies, loans, cash injections, grants, nationalisation to name a few.

government revenues will decline markedly. If they are unable to reduce expenditures then public debt default is an inevitable outcome. A government may be motivated to prevent private sector default by bailing out, increasing public debt and preventing its own default. The government would be reliant on being able to 'outrun' the crisis using public borrowing. We contend that a government with high debt will attempt to outrun the crisis by borrowing if it is able to do so rather than allow the private sector to default leading to public sector default. The political consequences of not bailing out the private sector, even when debt is at high levels, are likely to be detrimental to those that adopt such policies, for example Hoover Administration 1932 Presidential elections.

However, low public debt may give a different motivation if government debt levels, hence servicing costs, then it may be able to sustain a default in the private sector. Alternatively, if government expenditures (transfers and/or expenses) do not have sufficient flexibility the it must be a critical point where any expenditure reduction is insufficient to offset lost tax revenues. The motivation to bail out the private sector increases with the level of public debt. This seems counter intuitive to the benevolent government where one would expect that governments would use the buffer of low public debt to respond to decline in the private sector and that benevolence may decrease in increasing public debt. Effectively, if a government acknowledges that public sector default has undesirable economic and political implications then it can become trapped into funding the private sector until it can borrow no more.

Another aspect to consider is that changes to fiscal policy to re-stabilise the economy after a crisis may take some time, that is adjustments government expenditures, tax rates and social transfers, other than the emergency measures may take some time (Alesina and Drazen, 1989). Governments are unlikely to entertain austerity measures to create sufficient fiscal surpluses during a crisis, as that is likely to exacerbate rather than resolve the crisis[20]. Therefore, we assume that any re-stabilisation or interim adjustment policy by the government is ex-post the crises.

So, enter the foreign investor, that bring us to the next question why would risk neutral foreign investors continue to fund both public and private sectors under such circumstances? We need to look at the alternatives. If the foreign investor considers the option of not continuing to lend to the government at high debt levels then the government is almost certain to default and the foreign investor takes either looses everything or a significant haircut Likewise, with the private sector. A risk neutral foreign investor would exert a premium on the both private and public debt commiserate on the risk of either government or private sector default. An assumption of crises is that until one gets to the crisis, no one knows if the government will bail out the private sector and for how long. However, there is a limit for government, above which future primary surpluses will be insufficient to service the debt, the fiscal limit (Leeper and Walker, 2011; Polito and Wickens, 2012). There are many approaches to determining the fiscal limit including Laffer curve (Laffer, 2004; Trabandt and Uhlig, 2011; Fève, Matheron and Sahuc, 2017) or some derivative thereof as in Bi and Traum (2014, 2012).

Many papers explore public sector debt crisis including Bi and Traum (2014); Aguiar and Gop-

[20] Although recent 2020 pandemic responses in the US are stalled with little prospect counters this argument

inath (2006); Yue (2010); Fuchs-Schündeln and Hassan (2016, etc.), some consider the drivers of private sector on the public sector Reinhart and Rogoff (2011b,a, etc). There are a number of different 'traditions' in DSGE modelling public debt and the private sector. These include the tradition of Eaton and Gersovitz (1981) with followings from Arellano (2008) and Na et al. (2014) to name a few. These, at their core, a decision by an agent that weights the value of defaulting or continuing to participate with foreign investors. Alternatives come in the form a New Keynesian approach by Gertler and Kiyotaki (2015) and Gertler and Karadi (2015) where banker choose whether to renege on commitments leading to a recession, however, these models fall short of our goal in that they do not include public debt.

Next is to consider the DSGE models in the style exhibited in Bi and Traum (2012); Bi (2012); Bi, Shen and Yang (2016). These models use public debt, determining the interest rate from a cumulative distribution function where the probability of default is a function of either the level of public debt or public debt to GDP ratio. As to bank defaults with the including the sudden intervention what we observe is that neither government or private sector plan for a circumstance such as the last financial crisis. That is the private sector experiences a situation where mass default between private sector debt default decisions, the government's attempts to prevent private sector default by one or more transfers (bailouts) and, in some cases, a rapid expansion in public debt to levels where default is imminent. However, why does government enter into attempting to prevent private sector default? Starting with Yue (2010), De Paoli, Hoggarth and Saporta (2009) and where default incurs a loss to the economy through terms of trade and inability to smooth consumption implies that tax revenues will also be affected. Any sustained loss of tax revenue will eventually have implications for public debt if the default is in the private sector. The implication is that government may be motivated to bailout the private sector to maintain tax revenues if there are high levels of public debt and assuming that governments do not want to default.

One aspect to consider in bailout or interventionist policy is that lower socio-economic deciles are much more sensitive to income fluctuations and will act conservatively if uncertain (Dalziel and Lavoie, 2003). Hence they will curtail consumption or be forced to curtail consumption approaching the Keynesian 'subsistence' level. Although there may be sufficient capital supply capacity, the self reinforcing cycle of deficient effective aggregate demand that determines firms income and profits, hence their investment, will lead to decreasing labour demand and unemployment (Bertocco and Kalajzić, 2020).

Not only is the household vulnerable to default either on its own account or the bank, the government is also vulnerable to default from the decisions made in the private sector. This may lead to a Keynesian low equilibrium state that without outside assistance, a small open economy cannot recover. This puts whoever funds the bailout of the country in the policy making driving seat.

1.5.2 Post Crisis Policy

Is it more important to focus on government debt or private sector credit flows and debt? In many cases a private debt crises ends up as a public debt crisis though the bank transmission

mechanism that we discuss above Barth, Prabha and Yun (2012). Therefore does the public sector become the insurer of last resort for an unstable banking system (Acharya, Drechsler and Schnabl, 2014; Gennaioli, Martin and Rossi, 2014). A question for future investigation is do we want the government to be the insurer of last resort for the banking system or should it be the employer of last resort for the people? Are they mutually exclusive?

There is also some dispute on the policy approach post crisis, does it implement austerity programme or expansionary stimulus to the economy (Guajardo, Leigh and Pescatori, 2014). As we have discussed, the economic NGO's tend to adopt the neo-liberal, neoclassical theories in that post crisis, government need to address public debt and implement reform and austerity. Recent events in Greece, UK and others indicate a political backlash to long term austerity programmes resulting in inconsistent (and in some cases self harming) policies and instability (Krastev, 2012; Johnston, 2016). It is questionable if the accepted norm of most governments is to implement some form of austerity programme in an attempt to create sufficient primary surplus to reduce debt is a sustainable policy. Likewise, expansionism, especially with a small economy, is likely to run out of funds quite quickly without further external interventions. Then that leads back to the role of NGO's and their policies. With the 2020 crisis, there does seem to be some hope that the normally draconian measures are being somewhat moderated.

When a government does not have monetary control or control over the denomination of debt then its role of insurer is limited. If they do have monetary control then this provides a way that governments can respond to a crisis potentially addressing both the financial system and employment. If there is a choice to be made in the response hat factors does a government need to consider. If a government is constrained, then resolving the financial system or protecting the people is a choice it will potentially need to make. In developed nations and many of the higher income developing nations, a freeze in the financial system would cause the population to liquidate assets held in such institutions (the models of Diamond and Dybvig (1983) come to mind here) following Keynes (1936) view that in a crisis, liquidity matters and liquidity is in short supply. Therefore boosting confidence and creating liquidity would be the first order, as the economy would freeze quite quickly. That was the actions of the US and UK governments in 2008 and more belatedly, the ECB. This is where those countries with monetary control have the greatest advantage, the can respond quickly and stop a banking balance sheet recession turning into a national depression. This is why many of the countries that are constrained seek outside assistance.

This brings into question how effective will be the long term support to households across Europe with the 2020 pandemic? Although demand may slacken, households may be able to meet their obligations and consume. This might at least limit the lay-offs and at least limit the negative effects of unemployment (Bertocco and Kalajzić, 2020; Pavoni, 2009). One questions the logic of QE post the initial addressing of liquidity issues when both households and firms were still under stress and unlikely to borrow in such circumstances (Martin and Milas, 2012). Furthermore, the swift implementation of a range of macro-prudential policies lead the banks to be much more 'conservative' in their lending practices. QE may have lubricated some wheels in the economy, however it was and remains so, unable to restart the economy. the post 2008 evidence suggests that monetary policy is not necessarily the tool that many neoclassical

monetarist believe that it is. Maybe its time for fiscal policy to play a more active long term role that the neutered role assigned to it by the neo-liberal wing of economics. One could say, one bitten twice shy.

1.6 The Way Forward

In Chapter 2 we will explore the History of crises though the lens of 'two cities', namely developed and developing nations from a theoretical, historical narrative and empirical perspectives across many crises. Chapter 3 develops the foundation model that forms the basis for this work. We use a foundation scenario to simulate a number of different type of crises. Chapter 4 describes the underlying computational system that supports the foundation model, its extensions and the range of possible scenarios. Chapter 5 starts the process of exploration of the possibilities that derive from the foundation model by looking at the effects, particularly in crises, of different fiscal policies in response to debt and national income changes accounting for (in)consistency of policy. Chapter 6 discusses less passive interventions that normal fiscal policy in response to cycles by extending the model to allow governments to take an active role in crises. This somewhat resembles the 2008 crisis and its fallout as well as others. In this context we introduce the socio-political economic dichotomy that we observe in response to crises. Chapter 7 extends the model with the government adopting different defaulting strategies. Chapter 8 rounds out the model with wage rigidity and fixed exchange rates (akin to Greece) and considers way that fiscal policy influences taxation, social transfers and government expenditures. This discusses a range of possible fiscal policy implementations to achieve governmental objectives. Finally, Chapter 9 concludes by summarising the foundation model and all is extensions with the realisation of different policy and strategy settings though different scenarios and the potential for further development.

With the current policy options and strategy settings, we have set up over 11,500 scenarios and, though Chapter 3 to Chapter 8, explore the simulation of 47 different scenarios comparing them from different perspectives with the foundation.

Chapter 2

History of Crises

"When the capital development of a country becomes a by-product of the activities of a casino, the job is likely to be ill-done" - *John Maynard Keynes,(1936)*

2.1 Introduction

Understanding the historical context of crises provides us with the opportunity to identify potential causes, paths and the consequences with a view to improving the modelling, simulation and interpretation. Building on Chapter 1 initially discussing the how country development status affects dynamics of crises and the possible responses options. We then illustrate with some examples using the historical narrative from the Asian crisis. This we follow with an empirical analysis of different types of crises plotting their paths in key variables. We continue to use both a neoclassical and heterodox, particularly Keynesian, Post-Keynesian and MMT, framing to broaden our model development and interpretation.

Much of the history that differentiates developed from developing nations and their income classification by such organisations as the World Bank and IMF is as a result of colonial occupation during the nineteenth century and the post colonial era policies after WW2. As Western European countries retreated from previous colonies, they left a number of legacies including artificial borders between countries that did not reflect the indigenous make up of the population. Many of these ex-colonies were reliant on primary production including agriculture and mineral extraction that were largely owned by firms from the coloniser. Although many have significant resource wealth, the combination of political instability and outside influences, including the coloniser's own interests, has lead to those countries remaining in a economically poor state. Aspects include corruption, lack of law and civil enforcement, and ethic differences cause civil unrest. This is in stark contrast to the developed world where countries have institutions that limit the effects of criminal activity and enforce private property contracts. This extends to governance where strong institutions ensure a stable environment ensures economic and social policy are consistently applied (Kleiman, 1976; Angeles, 2007).

One particular aspect that results from this differentiation is that many developed nations have internationally recognised stable sovereign currencies. This facilitates trade with confidence

of investors and traders alike. That means that market participants are willing to trust the currency and buy public or private investments. One of the main criticisms levelled at MMT is that not all countries are like the USA. The perception of weakness makes them reliant on investment and debt denominated in foreign currency (Bonizzi, Kaltenbrunner and Michell, 2019; Mankiw, 2020). This has a significant bearing on the way that a country may be forced into a crisis and how they may respond. What seems to be possible in many developed nations in that bailing out the private sector with government funds may not be a course of action available to developing nations. One only has to look to developed nation responses to support business and in some cases, the population, with many trillions of dollars (or local currency) in the 2008 and the more recent 2020 crises and contrast them with the options available to developing nations.

2.2 Development Status and Crisis Response

2.2.1 Developing Nations

Most developing nations are more likely to experience debt problems that may impinge on productivity, capital growth and foreign investment, thus consigning them to the lower end of the income spectrum and limiting their market access (Turnovsky and Chattopadhyay, 2003; Mendoza and Oviedo, 2006; Gelos, Sahay and Sandleris, 2011). As we have discussed, one core aspect is the degree of monetary sovereignty is a limiting or improving factor for flow of credit (Bonizzi, Kaltenbrunner and Michell, 2019). Moreover, as pointed out in Na et al. (2014) debt, regardless of whether is it private or public, denominated in a foreign currency exposes the country to foreign exchange risk and particularly so for currency unions such as the EURO-ZONE (Farhi and Werning, 2016; Proaño and Lojak, 2015). Therefore, only when a country denominates or pegs its currency does it risk default by necessity (Kelton, 2020; Connors and Mitchell, 2017). As all debt is denominated in nominal currency terms, the value of that currency matters to both lender and borrower. We can say the ability to manufacture money or destroy it as it relates to sovereign debt is instrumental in the way that lender, borrower and the country strategises and performs any recovery. Furthermore, the resultant strategies in the developed world have reinforced the concentration of power in a limited set of 'too big to fail' institutions has concentrated power making smaller developed and developing nations 'price takers' (Longstaff et al., 2011; Strahan, 2013; Ioannou, Wojcik and Dymski, 2019).

Largely, international sovereign credit contracts is government by local regulation and jurisdictions. There may be measures in place to gain access to assets in the event of default, however such measures may not apply internationally nor can they apply them to sovereign debt. The foreign investor ability to recover may depend on the threat of sanctions. This may be limited to their own government's policies and willingness to enforce contracts[1] (Bocola, 2016). The only recourse open to foreign investors alone is that they collectively exclude defaulting countries from international credit markets for a period of time (Mendoza, 2013). This forces both

[1]Seizure may include, freezing assets, bank accounts, not permitting clearing of funds, whereas imposing sanctions on firms from the defaulting country limits their ability to access international borrowing.

parties to negotiate and the outcomes are dependent on the relative power each party has in the international markets and political systems.

The countries may experience differing degrees of impact of exclusion from credit markets. The lack of foreign investment funds, particularly counties with subsistence incomes, poverty, limited natural resources[2] and low savings rates. In addition, the lack of domestic financial infrastructure, has a significant impact on output and normally confines them long periods of poverty (Gelos, Sahay and Sandleris, 2011). A country where they are able to exploit resources or have substantial well developed economy, the effects of such sanctions could be less. The cost of default for lower income counties, may be significantly larger than the default itself in the long run. As such, enforcement of exclusion sanction (requiring market coordination) and seizure are at the crux of the willingness (or motivation) for a country, both private and public sectors, to repay its debts outside a mere commitment to repay.

Normally, modelling exclusion takes the form of a permanent removal from credit markets, particularly for developing nations. However, this is not borne out by the data (Yue, 2010). With historically low interest rates and the search for returns, some lenders may restart lending to a defaulting country with higher interest rates after short period. Furthermore, full default on all debt rarely occurs. Frequently, sovereign default is partial and ordinarily involves renegotiation normally though the Paris Accord. Hence it may be in the interests of the lender to continue to lend on the basis that 'something is better than nothing'. The threat of sanctions or the imposition of limited sanctions is normally sufficient to keep the country repaying whilst negotiating a settlement. Fine tuning the sanctions is important to ensure that the lender doesn't make the situation worse whilst maintaining pressure. Conversely a default in the private sector is more likely to result in a reduction in wealth with the seizure of assets and either high interest rates or a period of exclusion.

Resilience of the economy, however measured is an important differentiator between developing and developed countries. Debt to GDP ratio is seen by many as one of those core measures of resilience. Many NGO base decision making on public debt to GDP ratio to the extent that the EU (Commission, 2015), IMF and World Bank until recently, imposed severe fiscal policy constraints on both developing and smaller developed nations. However, this debt service affordability proxy does neglect the interest rate and the currency they debt is issued in. If a country was able to manipulate the interest rates on its debt then it can manipulate the level of debt that it can afford (Kelton, 2020; Joyce et al., 2011; Shah et al., 2019). This is not normally open to a developing nation thus making them vulnerable to NGO constraints and sanctions that reduce their resilience.

Next to consider is the stability of fiscal revenues and expenditures. If we assume that the MMT conditions do not apply, then debt service must accord with the primary surplus. Therefore, resilience of that primary surplus to shocks, regardless of source. A resilient economy has the ability to collect revenues efficiently whilst expenditures are used productively to enhance productivity without corruption (Bi, Shen and Yang, 2016). A case in point is Greece, although

[2]Limited may mean under developed natural resource such as minerals, hydrocarbons and includes agricultural resources

is in the upper end of income brackets prior to 2008, its revenue collection was problematic with its substantial grey market (Bi and Traum, 2014, 2012). In the post 2010 era for Greece had one of the most severe externally imposed austerity programmes that further weakened the economy's resilience (Blyth and Ban, 2015).

One of the core changes to the Paris club's focus from the initial resolving debt to the benefit of the lender was to move to a more developmental approach noting that it is in the interests of both lender and borrower in promoting resilience (Cheng, Díaz-Cassou and Erce, 2018). This contrasting view can be likened to difference in approach by the victors between the crisis post of WW1 and WW2. WW1 the victors imposed harsh economic penalties that lead to political instability. Whereas in WW2 the Marshall Plan promoted economic and political stability to rebuild resilient economies (Quinn and Woolley, 2001).

To summarise, the importance of what debt is denominated in, the level of independence of currency and the power differential between lender and borrower has significant bearing on developing nation's resilience to shocks. Moreover, the economic NGO's ideologies and policies throughout the last 50 years has possibly made developing countries' resilience worse. Fortunately, the Paris Club takes a wider pragmatic view in that it is in a shared interest to make developing countries more resilient by developing their infrastructure and institutions. Still, we see many macro-economists, political leaders and the media use simplistic measures such as debt to GDP to measure the distress and set policy as a consequence.

2.2.2 Developed Nations

Before continuing with the discussion on developed nations, it is important to differentiate between developing and developed nations. Nielsen (2013) describes the the different classification taxonomies for the world NGO's such as IMF. These largely focus on economic measures such as income and market structure. For example, IMF designates advanced (or developed) nations as "'relatively high income levels (comfortably within the range of those in the [existing advanced] country group), well developed financial markets and high degrees of financial intermediation, and diversified economic structures with rapidly growing service sectors." (IMF, 2001). One cannot discuss classification without drawing on Fernandez et al. (1997) which include a much broader sense of a country's value structures. However, both of these neglect a core factor, namely, rule of law, that is integrity of the legal system to secure property rights, enforce contracts and apply criminal matters evenly though its institutions and the legislative processes (Haggard, MacIntyre and Tiede, 2008). Moreover, the break down of the rule of law and possibly the legislative process acting in the interests of a few is likely to create inequalities in *any* nation state. For any classification system to separate developed and developing nations needs more dimensions that the classical economic factors. It goes hand in hand that rule of law, country value structures and economic factors need the infrastructural fabric[3] to support economic development (Haggard and Tiede, 2011).

[3]By infrastructural fabric we mean both physical infrastructure, social and political institutions, rule of law and social safety nets

The infrastructural fabric of a nation provides it with the resilience to withstand shocks to the economy and the people. A very clear and recent example is that of the Covid-19 pandemic that has put the institutions and socio-political infrastructure under pressure. This has brought into visibility the weaknesses in the social fabric of even developed nations. Moreover, the 2008 crisis and its fallout brought about some to question the ability of some nations to survive in the European Union. The breakdown of the socio-political infrastructure, where people beleive the economy does not work for them, permits political extremist ideologies to gain a foot hold with disastrous consequences. It is a short road to the breakdown of socio-political order, the shortness of that road is how resilient the infrastructural fabric is and the willingness of the people to defend it (Snyder, 2017).

On the economic front, some aspects to consider regarding crises and developed nations. As we have already indicated, the financial infrastructure and interconnectedness is an important part of a developed nation's sustaining its wealth and standing. However, the institutions that compose the financial infrastructure themselves are, by their own design, unstable (Minsky, 1992, 1964; Kregel, 2008). In part, this instability drives the developed capitalist economy with somewhat infrequent clearing away of 'old' industry with the replacement of new developments, the creative destruction (Schumpeter and Redvers, 1934). However, if that results in people believing the economy does not work for them then this gives opportunity for self-interested political actors to undermine the infrastructural fabric of the nation[4]. However, in the last major episode, the economic cost is not bourne equally nor was the benefits of interventions by government or government agencies tended to benefit those with wealth. What starts as an economic crisis can develop into a socio-political crisis providing the opportunity for either those that seek to authoritarian rule or, now less frequently, overthrowing of the very institutions and governments. With economic strength of a developed economy, must come the institutional strength to ensure that crises do not destabilise the very foundations of the strength.

2.3 Historical Analysis

> Those who cannot remember the past are condemned to repeat it - Santayana (1905)

2.3.1 Sovereign Debt, Surpluses and recessions

Leading up to the 2008 crisis, Chan and Duggar (2007) undertook an analysis of a number of sovereign defaults almost exclusively in developing countries in all regions. Of particular interest is their analysis of the circumstances around defaults, a number of defaults and recovery rates. Note that in 2007, there were no sovereign default, a circumstance that would change over the next three years. One aspect is that many of the developing countries, particularly those with larger economies such as India and Brazil use a combination of foreign and

[4]Case in point is Russia since 2000, a near miss with the USA in 2016-2020, Poland, Hungary, Burma are all examples of institutional undermining

domestic currency bonds. This mix had a significant bearing on the ability of the country to service its debt in times of stress. This is quite unlike the US and UK where debt is almost exclusively denominated in its own currency and the currency has sufficient resilience to withstand sovereign distress. We will discuss later in this chapter the views expressed by the MMT (Wray, 2019).

However, before proceeding into a historical narrative on the pathways though crises to recovery, it is important to understand an often forgotten aspect that affect young nations, even if they issue sovereign debt in their own currency. In the United States, successive federal governments have attempted to repay sovereign debt since the beginning of the 1800's. Table 2.1 sets out the years that the federal government ran a surplus, how much federal debt was discharged and year that the next recession or depression began. Wray (2019); Kelton (2020) hypotheses that surpluses turn into recession. To explain, starting with the federal government running a primary surplus that exceeds that if the debt service cost and sufficient to repay principle. This means that the private sector has to run a gross surplus sufficient to pay the taxes and levies and carry out investment activities with a lower effective aggregate demand. The Federal government retiring debt that is partly held domestically, provides an inflow of funds proportionate to the debt held. However, a significant proportion of that debt is foreign held (as in the case in the US), therefore this would generate a capital account deficit. Tax revenues are compulsory on the private sector and investment is not. One could envisage a situation where tax revenues were substantial enough to effectively take the majority of the private sector gross surplus without the compensation of revenues from federal debt retirement. This, crowding out new investment and potentially impinging on depreciation reinvestment.

Surplus Years	% of debt pad off	Recession starts
1817-21	29%	1819
1823-36	100%	1837
1852-57	59%	1857
1867-73	27%	1873
1880-93	50%	1893
1920-30	33%	1929
1998-2001	13.6%	2001

Table 2.1: US Past attempts of paying off Public debt (Federal) and Depressions Source: Minneapolis Fed

Taking this to bank lending for investment then banks will observe less net revenue for firms and reduce their investment lending accordingly. Collectively, the suppression of investment is likely to progressively weaken the private sector, particularly if there is a capital account deficit driven largely by government debt retirement. In Table 2.1 one observes the correlation between a recession starting and the end of debt repayment. As the recession starts, tax revenues fall curtaining debt repayment and possibly making the recession worse. Instrumental was the role of the banking sector and pension funds In the last two periods (1920-30 and 1998-2001), both of which are reliant on the sovereign bond market to provide a safe asset that can be easily liquidated. If there is a shortage of such instruments, then the price will rise, yields fall

and the same effect as the later QE programme is likely to occur. The difference is this is driven by fiscal policy not monetary policy (Joyce et al., 2012). As such, in the search for returns investment houses will seek ever increasingly risky assets that constantly rise in the market until 2001 (or 1929!) that is well explained in Galbraith (1994) following a Minskyian path.[5]

2.3.2 Historical Narrative Regional Analysis

Here, we draw on the Asian financial crisis where many governments and the private sector borrow from foreign investors in a mixture of their own domestic currency and foreign currencies. As a foundation, we use the texts of Radelet et al. (1998); Johnson et al. (2000) to form the basis of this historical analysis. In addition we will include the Argentine collapse so often reported in academia to draw out any particular aspects common to all the crises. we will cover Thailand, Indonesia, South Korea and Malaysia as representative of the Asian crisis.

Prior to the crisis (1997), Thailand had reasonably rapid growth (~9%) and moderate inflation (~4.2%) with rapid expansion in its manufacturing base. At the time there was a currency peg at 25 pesos/USD, that came under a speculative attack. Unable to maintain the peg (lack of foreign reserves), the currency was floated and it immediately devalued by 50%. Much of the country's borrowing and many of the imports were priced in USD that brought a sudden stop to the economy with many of the financial institutions becoming insolvent. In this case, the government required outside assistance (the IMF) with the proviso of strengthening its regulatory frameworks. The rapid increase in unemployment and the release of foreign workers (600,000) as a result of the contraction increased the level of poverty in Thailand and transmitted the crisis to other countries. The crisis occurred over a three to four period with sustainable recovery occurring by 2001. To summarise, a currency crisis, that transmitted to financial sector by foreign borrowing and the sudden economic stop. External intervention (IMF) granting and lending created sufficient capital inflows for the government to bailout the private sector. A short, painful crisis, where the pegging acted against the country rather than a gradual depreciation that would allow industry to adjust.

By contrast, Indonesia had a stable with a significant trade surplus with a growing banking sector, foreign reserves and industry. It had a soft pegging band with the US with many business borrowing in USD. After the Thailand's float, the Ru came under pressure in a similar way to the the Baht. Widening the soft peg was insufficient and floating had the same effect as Thailand, immediate depreciation, however not to the same extent. The issue was Corporate debt priced in USD was expanding as the Ru depreciated and the possibility of mass default. Contraction in firm's activity and unemployment plus those returning from Thailand unemployed made the situation much worse. Again IMF bailout package to the government progressively stabilised the economy that took some five years to recover to pre crisis levels. Again foreign

[5]Some aspects to note, is that until 1863, there were also multiple state currencies and money notes issued by banks with local exchange rates and the institutional restructuring under the Federal Reserve in 1913. This evolution of institutional management of money has some bearing on the way that Federal government issue and manage debt. There are many ways that the Treasury can fund expenditure using the Federal reserve that includes bond issuance, reserves, money issuance by way of example. Effectively, the Federal Reserve is the Treasury's banker and the Treasury can run an overdraft with the Federal Reserve. This is the dicotmy between the MMT school and most academic work.

currency borrowing in the private sector lead to a sovereign crisis that needed external intervention. We can treat the IMF as a benevolent foreign investor that acts as a 'lender of last resort'.

A major difference between Indonesia and South Korea is that South Korea adopted an aggressive expansion strategy that borrowed from domestic banks that in turn borrowed heavily from overseas. The expansion was unsustainable in that insufficient profits with unproductive absorption of capital investment. The instability in the region lead to a small downturn in revenues [6] that caused many large corporations to enter bankruptcy, thus creating a banking crisis. Again the IMF stepped in forcing many reforms and significant bailout package reversed the free-fall of the economy. However, the government ended up with a much higher debt to GDP ratio (13 to 30%) as GDP declined and government revenues fell. Again, the private sector with poor lending practices and corruption needed bailout. The problem was banking and the private sector rather than currency that nearly lead to a South Korean public debt crisis.

Malaysia was much more of currency crisis, again pegged, in part driven by the Baht revaluation and a loss of confidence. Foreign investors started to deleverage leading to capital and currency controls. Unable to fund the expansion and influx of labour from other countries lead to a recession. Unable to service debt, and with rising defaults, banks became at risk of failure requiring government recapitalisation, thus increasing their sovereign debt. Malaysia's recovery was much slower than any of the others.

In summary, attacks on fixed exchange rates that caused contraction in the domestic economy that then lead to the banking system being under stress. Every one of the countries bailed out corporations and banks from either their own government resources or grants/loans from the IMF. In all cases the crisis were sudden and resulting in deep recessions with all of the knock on effects.

Argentina was different to the Asian countries. Although they shared a currency peg, the 2002 crisis was the culmination of a series of crises in the 1990's. This case was a combined public and private debt crisis with most private debt in USD. This constrained the Central Bank as interest rates had little influence on inflation. As the USD was appreciating, the peg forced the peso to appreciate resulting in declining export revenues. High unemployment and high public sector borrowing lead to domestic cash shortages. As soon as the peso floated, immediate devaluation that caused a trading stop in banks and firms. Worsening trade and unemployment compounded government's debt position resulting in default and a 75% haircut on all government debt. Inflexibility in the labour market inflexibility, poor government fiscal management, with a lack of appropriate macro-prudential oversight on the financial sector compounded with a currency peg lead to a crash. This is quite different to the Asian crashes, in that the government effectively created the circumstances of the crash. Eventually, foreign investors (including the World Bank, IMF and the US Treasury) provided the funds to reflate the economy. However, only on the condition that government implemented significant austerity measures and reforms. Part of the response was a significant pay and pension cut across the board. Unemployment took many years to recover that imposed a severe drain on Government resources.

[6] Complicated with a significant level of corporate and public sector corruption

The above illustrates three types of crisis, that is a currency crisis, a banking crisis and a sovereign debt crisis. These particular examples stem from some form of currency control and structural/institutional problems in the economy. In all cases, labour was impacted, as was government debt (when it was the private sector). All the economies required some form of intervention from foreign sources to reflate the economy. We will incorporate all of these factors into our modelling.

2.4 Empirical Analysis

We conduct time path analysis across multiple crises using the dataset in Laeven and Valencia (2018) that are classified into banking, currency, sovereign and recovery for the period 1971 to 2017. This represents the modern era of financial development and the maturing of many of the NGO's policies[7]. Each event date in Laeven and Valencia (2018) defines the coordinating point for the consolidation of data across all the datasets[8]. We select 12 annual periods to cover the period before and after the crisis. We then select and normalise nominal GDP, government and private debt, (y, d^G, d^H respectively) by dividing each level by the average over the 12 periods for each event. With unemployment is expressed as a percentage unemployed and GINI is scored from 100 where 100 represents maximum wealth inequality are already normalised therefore we just select the data accordingly. A question is why can we use banking crises in lieu of private debt crises? Most private debt is funded by banks as we have discussed therefore, we will use banks as a proxy for private debt and default[9].

The debt (private and public) as well as GDP derives from the IMF's Global Debt Database as set out in Mbaye, Badia and Chae (2018), unemployment and GINI are from the World Bank WBI database (2020). Country income category are from World Bank (2018) with High (A,B) Middle (C,D) and Low (E,F). Each crisis is classified by Laeven and Valencia (2018) that enables us to filter the data down to specific crises classification and/or income category.

We report the results with graphs Figure 2.1,Figure 2.2 and Figure 2.3 that show the mean time-path for each event and income classification. Note that the frequency of some of the more subset charts rely on a small sample of and then applied to the data by filtering on country, crisis and income classifications, and event timing. We use Banking crises classifications as a proxy for private debt crises and sovereign debt crises as a proxy for public debt crises. As currency crises can affect either we do not explicitly associate these crises with either public or private. One can observe from the historical analysis above that currency crises can associate themselves with ether public or private crises. We include currency crises for completeness. We report the breakdown of the frequency of default by income category in Table 2.2 . As expected

[7]NGO means World Bank, IMF, OECD and other similar organisations

[8]A useful source for sovereign default data is the Bank of Canada in conjunction with the Bank of England's Sovereign Default Database Beers, Jones and Walsh (2020)

[9]The alternative is corporate bonds and secondary lenders. Neither represent the bulk of lending to households or firms. Banks rely on household and firm private debt stability to maintain their balance sheets. This implies that if sufficient households (or firms) default, then the bank will itself default by becoming insolvent. In the 2008 crisis, banks defaulted on their debt (bonds and deposits) when the delinquency rate on household loans markedly increased. Therefore, banks are a proxy for the behaviour of households when modelling default in a crisis situation.

default events tend to be more frequent in low and middle with low middle income categories being twice as frequent as high income. Note that Sovereign defaults represent only 14% of the total number of default which brings into question why is much of the neoclassical literature focused on sovereign defaults rather than the more frequent currency and banking crises. Just from this frequency data, banking represent the greatest threat to high income countries and that currency has an equivalent threat to middle and low income countries.

	Income Group			
	High	**Middle**	**Low**	**total**
Number of Countries	*78*	*53*	*82*	***213***
Banking crises	56	61	100	**217**
Currency crises	41	61	98	**200**
Sovereign crises	14	22	32	**68**
total	**111**	**144**	**230**	**485**

Table 2.2: The number of crises during the period 1971 to 2017. The first line is the number of countries by the World Bank income category. The lines, Banking, Currency and Sovereign represent the classification of default as defined in Laeven and Valencia (2018)

2.4.1 Banking Crises

Banking crises represent the most frequent crisis event in all income categories. In Figure 2.1 at the point of the bank crisis, private debt deleveraging occurs reducing the level of private debt that is then followed by a period of growth. A driving factor for these banking crises seems to be a recession in the years before. Note that public debt climbs sharply post crisis, something that we observed in the 2008 crisis. Although GDP grows, we also observe unemployment growth as well post crisis. A possible explanation could be found in Post-Keynsian (Dalziel and Lavoie, 2003) and Keynes (1936) where deleveraging by the banking sector in crisis restricting the flow of credit, thus slowing investment (or in some cases forcing firms to divest) and the easiest cost to remove is labour, hence unemployment. However, contradictory is the increase in output. This seems to follow the increase in public debt that is either related to unemployment and or intervention in the private sector. Further investigation is necessary to establish the interactions between these variables. One not unexpected aspect is the growth in wealth and income inequality illustrated by GINI.

if we now compare low income, middle with high income then we would expect an observable difference due largely to the structure and maturity of the financial infrastructure that affects level of private debt.. A point to note is that banking crises where there is some form of government intervention are much more prevalent in the mid to high income countries whereas, low income countries have a less mature banking system and less of the population relies on it. First, compare middle income with high income as they will have both a reasonably well developed banking system, significant private sector lending and a large proportion of the population using it, therefore exposing the country to banking risk. As we have already discussed,

public debt increases in response to the crisis. Whether that is bailing out or revenues, the outcome is the same. Note that public debt continues to climb in high income economies, whereas there is a tailing off in the middle income.

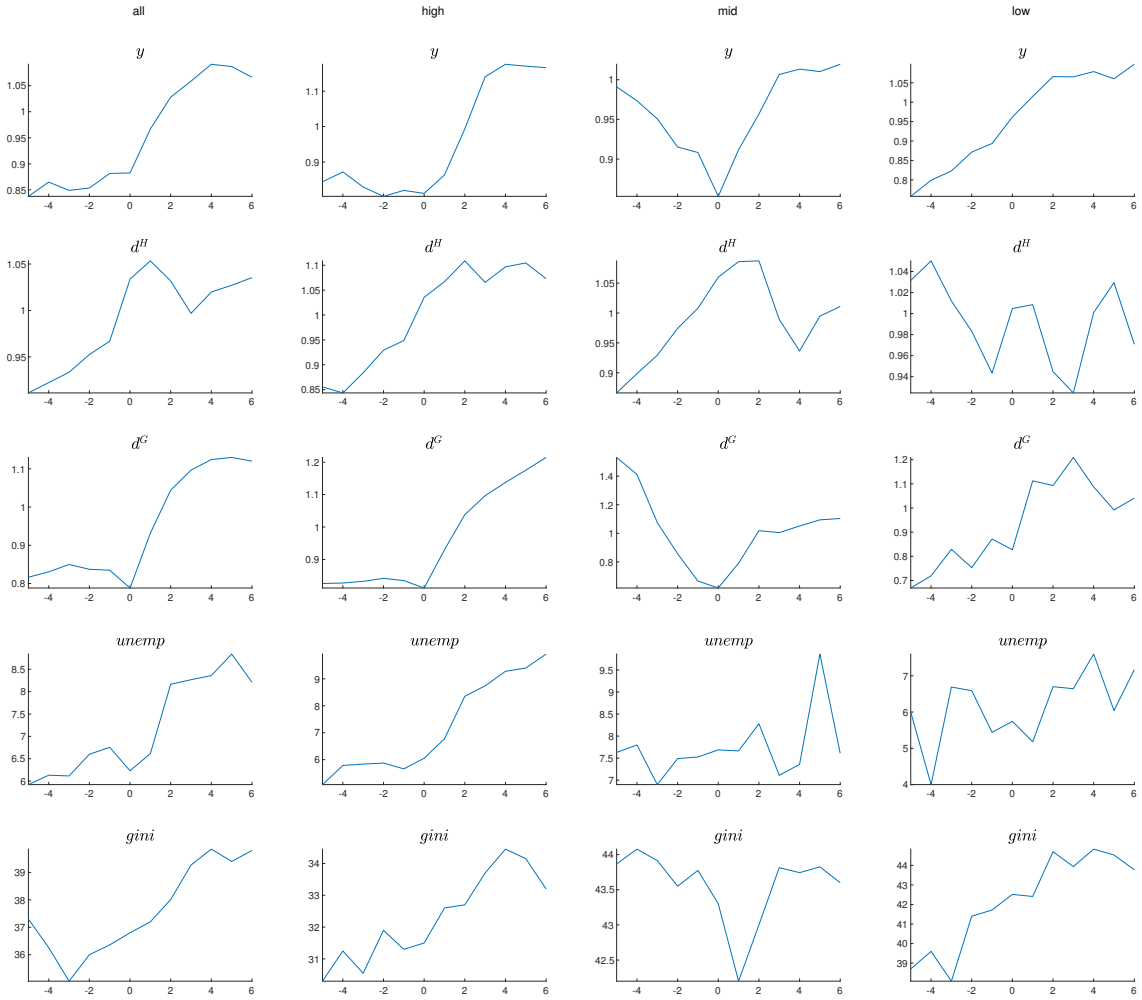


Figure 2.1: Banking Crisis - Columns from left to right are All crises, then by income classification: high income, middle income. low income. The variables are y is GDP, d^H is private debt, $d^G$is public debt, $unemp$ is unemployment and $gini$ is the income GINI index. This includes multiple banking crises across all countries. The data is normalised to mean (except for GINI) by calculating the deviation from the mean for that sequence, all sequences are then aligned on the crisis date and the chart reflects the mean path across all of the sequences.

A interesting observation is that middle income economies have high level of public debt before the crisis and that seems to collapse, implying that government may also be defaulting at the same time. Regarding private debt, high income seems to have a small correction whereas that correction after the crisis is much more pronounced in middle income countries. Note that the decline in income, y is much more sudden in middle income countries, whereas high income countries seem to have a period of recession leading up to the crisis. One could hypothesis that high income the recession might be the factor that puts the banking system under stress whereas middle income suffer an externality or some from of institutional failure prior to the crisis. This would be the case with the Asian crisis (Johnson et al., 2000). In high income, the

progressive rise in private debt (approximately 10%pa) immediately prior to the crisis seems to support the latter stages set out in Minsky (1992) leading to the liquidity crunch as in Mendoza (2013).

We can see that unemployment increases rapidly in high income countries as a result of the crisis whereas we only observe a peak sometime after the crisis for the middle income countries. Labour costs in high income countries tend to be higher, however companies may 'hang on' to labour in a recession and it is only the crisis that releases the labour. Following the theories of debt deleveraging, one would expect that the deleveraging that occurs in middle income would have a much more pronounced effect on unemployment. This would be an interesting point for further analysis beyond the scope of this work.

Lastly, inequality, Note that the mean level of inequality is much greater in middle income countries and there is a sudden drop in inequality at the point of crisis. This is possibly driven by financial asset wealth taking a significant downgrade then recovering as we have seen in the early stages of the 2020 pandemic. However, this is temporary and the economy returns to the same levels of inequality. This in stark contrast to that of high income where we observe a progressively worsening inequality throughout the crisis period. Although high income economies start at a lower level there is a significant change that flattens off after 6 years post crisis. Note that middle income inequality averages 42/100 whereas high income remains below 34/100. Middle income countries tend to have a significant proportion of the population near poverty levels and a wealthy minority that would cause the GINI to reflect high levels of inequality.

We include low income countries for completeness. One aspect is that private debt does not deviate much in response to the crisis (the range is small), nevertheless, government debt does increase markedly much more inline with high and middle income. Interestingly, inequality is initially *less* in low income countries than that of middle income possibly implying that the burgeoning wealth class has not developed possibly aligning itself to the industrialisation status of the country.

In summary, banking crises inevitably end up with some form of wealth transference from the government to the private sector whether that be via a bailout or tax revenue losses though corporate losses. High income countries suffer a consistent and progressive climb in unemployment possibly though companies attempting to save labour costs and moving more to automation.

2.4.2 Currency Crisis

According to Eggertsson and Krugman (2012) and Benigno and Romei (2014), a currency crisis is when the confidence in the domestic currency causes a significant depreciation in its value making foreign funded debt servicing unsustainable. Thus leads to a mass private debt deleveraging[10] and a rapidly increasing level of public debt as service costs compound. As such, a currency crisis may provoke a banking crisis that follows soon after. The important aspect is

[10] possibly though default

the effect of deleveraging on the domestic economy is the affect on effective aggregate demand. This may, in part be compensated for by the increase in exports, therefore GDP, however, industries that only provide domestically may be hard hit. So what we might have is a domestic recession and an export boom. We observe this dynamic in the general case of all countries currency crisis Figure 2.2.

A currency crisis tends to have significantly different private debt dynamics if one accounts for income category . Both show climbing public debt and increasing unemployment at the periods around the crisis. However, in high income countries, there is a significant period of deleveraging *ex-post* crisis. Moreover, there is a significant period of private debt accumulation *ex-ante.* Again, unemployment increases dramatically though the main crisis period and then stabilise at a high level. Possibly we can explain this with deleveraging affecting both consumption and investment.

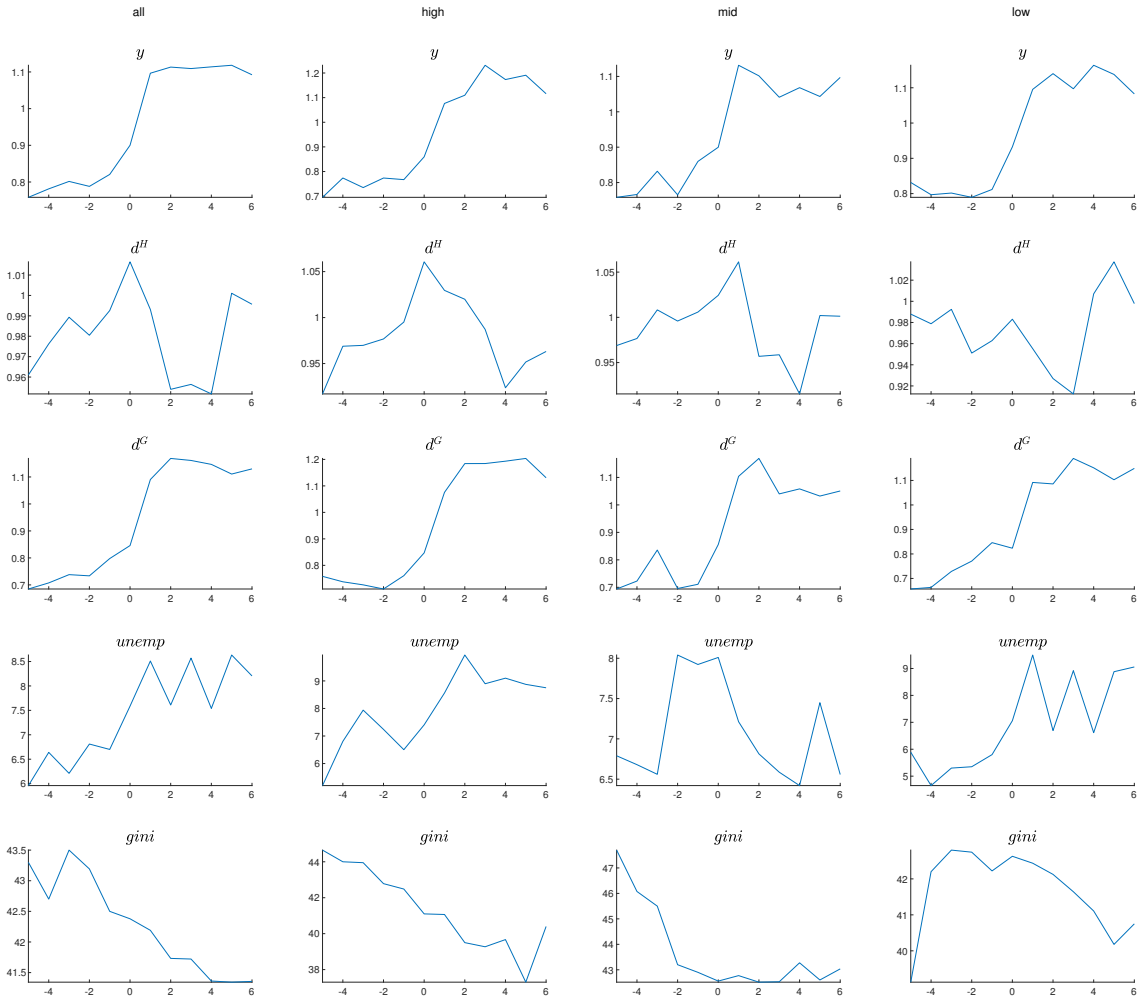


Figure 2.2: Currency Crisis - Columns from left to right are All crises, then by income classification: high income, middle income. low income. The variables y is GDP, d^H is private debt, $d^G$is public debt, $unemp$ is unemployment and $gini$ is the income GINI index. This includes multiple banking crises across all countries. The data is normalised to mean (except for GINI) by calculating the deviation from the mean for that sequence, all sequences are then aligned on the crisis date and the chart reflects the mean path across all of the sequences.

Most high income countries that experience a currency crisis tend to be impacted in the private sector with a rapid depreciation of the local currency ramping up funding costs for the financial sector thus reducing the interest rate spread, therefore the desire to lend and creating a liquidity trap that suppresses aggregate demand (Eggertsson and Krugman, 2012). In contrast, the range of deviation for private debt in low income is small in comparison. A possible explanation is that the level of private debt is likely to be substantially lower in developing, low income countries. An interesting factor that comes out of high income is that the GINI index decreases[11]. However, in the low income case, it remains flat until sometime post crisis.

2.4.3 Sovereign Debt Crisis

Much more focus it put on sovereign debt crises than either of the other two classifications and we have fewer events to use as the basis for analysis. Another aspect is that we do not know if the sovereign default is as a result of the government propping up the private sector, that is it could be associated with a banking crisis or external factors to the economy. Sovereign debt crises may also be linked to a currency crises making public debt unaffordable to service, particularly if the majority of the debt is in foreign terms.

Starting with the general case, that includes all income categories Figure 2.3, then there is a marked decline in both private and public debt starting approximately one year after the crisis. If government and private sector are deleveraging then both are creating surpluses to achieve that, otherwise either or both government and private sector are in the process of defaulting and writing down debt. Although income increases, classical debt deleveraging or defaulting creates a depreciation in the exchange rate (although exchange rate depreciation may be the source of defaulting) (Benigno and Romei, 2014). In concert with the private sector deleveraging, there is a rapid increase in unemployment and inequality. Then inequality falls for some reason. Likely, is that asset wealth is negatively impacted by the deleveraging in the initial periods and depending on monetary and fiscal responses such as a QE programme, targetting may create greater inequality. Generally, unemployment and inequality become worse as a result.

The high income category for sovereign defaults shows a similar pattern to that of the general with the similar decline in debt . An important difference is that unemployment peaks at the crisis at a very high level between 12 and 14% and only slowly declines over the subsequent years. In regard to inequality, prior to the crisis a progressive increase as wealth is accumulated in the upper deciles, with a sharp drop in the GINI possibly as we have described above, asset revaluations being realised, however, this soon returns to higher levels and once private debt stops deleveraging, then inequality increases to a new, much higher level. Until recently, economic NGO's exerted power to force governments to implement austerity programmes as a condition of receiving funding from them. Many of the southern European countries that cannot use inflation or exchange rate depreciation effectively were forced to implement quite serve austerity programmes (Blyth and Ban, 2015; Bi and Traum, 2014). Note that although income increases past the crisis, it stops two years after the crisis, this matches Greece's experience,

[11] that is inequality is deceasing

where post crisis bailout Greece defaulted on part of its debt and bailout conditions forced a marked decline in income with unemployment climbing to record high levels.

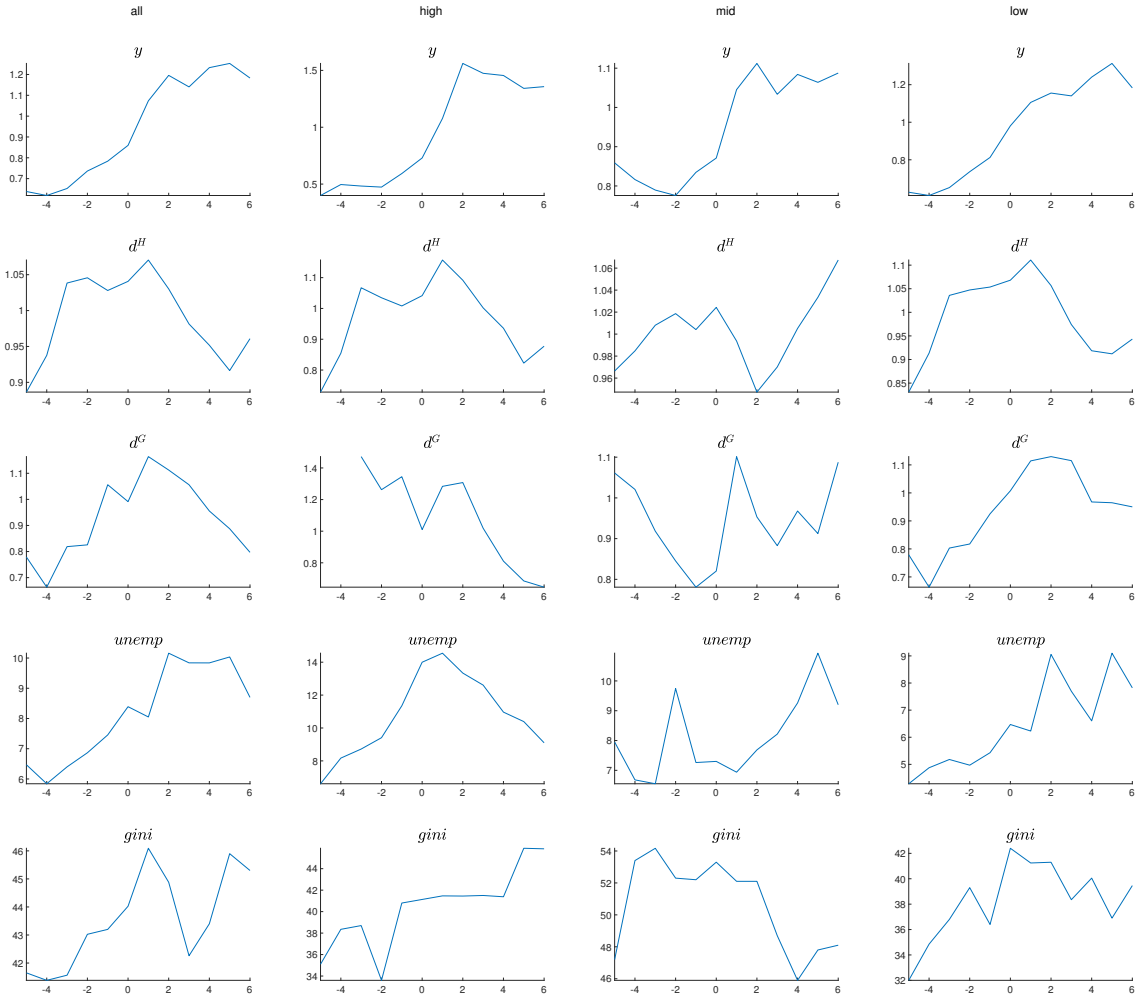


Figure 2.3: Sovereign Debt Crisis - Columns from left to right are All crises, then by income classification: high income, middle income. low income. The variables y is GDP, d^H is private debt, $d^G$is public debt, $unemp$ is unemployment and $gini$ is the income GINI index. This includes multiple banking crises across all countries. The data is normalised to mean (except for GINI) by calculating the deviation from the mean for that sequence, all sequences are then aligned on the crisis date and the chart reflects the mean path across all of the sequences.

If we now consider the lower income category then we observe some similarities to that of high income in the increasing in unemployment and a pre-crisis change upwards in inequality. However, government debt climbs markedly though the crisis period and then falls afterwards possibly implying that the is some limit on government debt and that some form of defaulting strategy attempt to repay as much as possible. This is somewhat in contrast to that of middle income countries, where there is an extreme spike in debt that then is defaulted on repeatedly. This is a significant difference in the behaviour of private debt where there is a steady growth in debt. Note the level of inequality is much higher during a crisis analysis period averaging 51/100 whereas low income is in the range of 38/100 and high income Figure 2.20/100. These middle income countries are progressively industrialising and the labour market still reliant on

low wage occupations. One characteristic that correlates during the post crisis is that private debt deleveraging seems to start unemployment and flatten output. Although there is increasing indebtedness in the private sector after the post crisis deleveraging it seems to not make the difference. There maybe an interaction with currency as most middle income countries borrow in a mix of foreign and domestic currency. Again the deleveraging and exchange rate explanation in Johnson et al. (2000) tempered with a short term recovery in the short run (Bonam and Lukkezen, 2013).

2.5 Conclusion

From both the historical narrative and the empirical analysis we can see that the role of private debt has significance in most medium to high income countries. This is contrary to the normative that public debt is the principle cause of many crises, it is the consequence of crises. There is some significant differences between developed and developing nations in the ability to withstand crises without the need for external intervention from NGO's. Such interventions come with the baggage of austerity and reform that in some cases works against recovery and resilience. As we noted in Chapter 1 and further elaborated here, the consequences of eroding the infrastructural fabric of a nation makes them less resilient to crises and more likely to experience civil unrest and turbulence. Although the institutions of a developed nation may be strong, recent events indicate that the road for extremism is made easy by ideologies that economically disenfranchise the majority of the population.

Chapter 3

Foundation Model and Scenario

3.1 Introduction

Our foundation model derives from the work of Eaton and Gersovitz (1981) with both Arellano (2008) and Na et al. (2014) extensions. We extend the model considerably by including private debt separately from public debt; the cost of servicing that debt deriving from the willingness to repay and the ability to repay, a public debt repayment curve following Reinhart and Rogoff (2011b) and a fiscal policy rule similar to that of Cantore et al. (2017). Fiscal policy determines social transfers, government expenditures and taxation rates. The monetary policy follows that of Na et al. (2014) with an exchange rate determination by the marginal utility between tradable and domestic goods.

The core characteristic of this model is that all debt, public or private, is denominated in foreign currency. In our prior discussion, we show the difference between public debt in domestic currency and that, where public debt is in foreign currency or some form of pegging, fixed exchange range or banding. This imposes a significant restriction on the government's ability to respond to a crisis with borrowing in a foreign currency where risk neutral lenders will exact a risk premium on excessive debt. Effectively, the government carries both the risk of the crisis and the risk of a depreciation in exchange rates that markedly increase the cost of servicing public debt. This establishes that the government has a lifetime budget constraint following the traditional RBC style models.

The separation of private debt from public debt , both denominated in foreign currency, means interest rates follow their own track. Common for smaller developed and developing countries' banking systems to use foreign resources for their liquidity. Normally, the domestic economy does not have sufficient resources to cover all of the liquidity requirements. For the purposes of this model, we assume that banks do not create money or that creation is limited by some legal or macro-prudential requirement that we can treat banks as purely transformational, passing though the risk of default from the household to the foreign investor, thus becoming invisible. Although this is contrary to our prior discussion that banks create and destroy money in the lending process, it maintains that an equilibrium can form which determines the willingness and ability to repay without the complication of taking into account banker's preferences for

risk and profit. Therefore, the constraint on the private sector is a lifetime budget constraint of the traditional RBC form.

If we are going to consider default, then we need to have some exogenous process that generates foreign exchange income to service the debt. Following both Eaton and Gersovitz (1981) and Na et al. (2014) we construct a $AR(1)$ stochastic process that may force the household to consider the choice between defaulting and continuing to service the debt. The decision making by the household includes the cost of default, that is suppressed foreign exchange income whilst being excluded by lenders. There is trade off between reducing consumption to service debt and that of maintaining consumption today, then experiencing the cost of default in the hope that fortunes will reverse sooner rather than later.

One of the extensions which we take up from Na et al. (2014), of the foundation Eaton and Gersovitz (1981) model, is that of non-internationally tradable goods and non-tradable or domestic goods and that of the tradable goods income stream above. This creates an exchange rate between tradable and non-tradable goods, determining the price of domestic goods in foreign goods terms. Again following Na et al. (2014), and the Marxian principle that all capital derives from labour, we adopt that firms produce goods using labour only. Funding for this is by the household, and the household supplies labour for an labour wage income. One could liken this to a developing economy model where capital (both private and public) are somewhat limited and it is the fruits of labour that generate the goods.

Need to consider if the household compensate for the lack of foreign income in downturns, with increasing production in the domestic sector. This would, of course, result in more labour; something that the household will balance with that of the utility of consumption of domestic goods. However, this is not certain; increasing production using labour only, may result in a decreasing marginal productivity though decreasing economies of scale. How could this be realistic? Firstly, there is a finite limit on the labour hours and secondly, there is plenty of evidence that increasing labour input does not necessarily result in a similar factor increasing in output.

In a downturn, if the demand for labour is in decline then would labour reduce its wage rate to ensure full employment? This assumes fully flexible wage rate setting, something that we do not necessarily observe in developed economies; however, in developing economies, wages may be somewhat more flexible. In this foundation model, we will start with flexible wages, and in a later extension we impose downward wage rigidity with fixed exchange rates similar to that of a currency union or peg. Therefore, the domestic sector interacts with the foreign sector through the household's consumption and labour preferences under the constraints of the price of domestic goods in foreign terms. A household therefore may experience inflationary or deflationary pressures in their decision making. This we explore later in the theoretical and simulation sections below.

Turning now to the government and the somewhat unrealistic propositions in both Na et al. (2014) and Eaton and Gersovitz (1981) about the role of government. Many models consider government being benign, static and almost being portrayed as parasitic on the private sector. We have already devoted much discussion to the role of government that we will not cover

here. Suffice to say, that we model government that is dynamic with a policy rule, variable taxes and social transfers. This more fairly reflects government activities does in the real economies. Our foundation is a fiscal policy rule deriving from Cantore et al. (2017) with adaptations to suit our particular needs. Cantore et al. (2017) is a New Keynesian rather than a RBC style, however it suits our needs and is simple to understand and calibrate. To create the realism, we make policy making look forward and take into account the current policy settings, the level of tradable output and the current level of government debt. This then sets the tax rates on consumption (supply side tax) and labour (demand side tax) as well as the government expenditures on social transfers and general government expenditure. This mimics the budgetary process that we observe around the world using the legislature to approve budgets in advance. Consumption tax applies to both tradable and domestic goods whereas labour taxes only apply to the domestic market for labour. Social transfers and government expenditures apply to both tradable and domestic sectors. This then ties the executive part of government to set taxation rates, hence forecast income and largely pre-determine the expenditures necessary for its functions. Furthermore, households know the tax rates they will need to fund and social transfers they will receive in advance. Hence the more replicates the normal budgetary cycle and feedback loops that we observe in many countries.

The government seeks to borrow from foreign investors to fund any shortfall in primary surplus.This borrowing it also needs to fund any debt repayments and the interest therefore is inter-temporally budget constrained. Government needs to run primary surpluses to fund debt servicing. Juxtaposed is the real world, most developed economies run a primary deficit and have done so since WW2, and likewise with many developing economies.

Normatively, the expression of government debt is in the form of Debt to GDP ratio. In the EU fiscal responsibility area, part of the Eurozone, a debt to GDP ratio of 60-65% would be the target. Many countries seek to reduce their Debt to GDP ratio to as low as 28%[1]. Many see that reducing debt as 'good' for the economy, particularly those promoting fiscal responsibility. For example: UK 2010 budget[2]. However, government could choose to increase GDP rather than reduce debt stock. As we have already discussed, if a government can seek to invest (that is government expenditure), improving productivity, it can reduce the debt to GDP ratio.

In our setting, where governments cannot create the money, it needs to borrow from foreign investors and then deploy those funds as transfers, either directly or indirectly, into the private sector to boost productivity. This could be problematic for the foreign investor, in that if the government is unsuccessful or there is a depreciation of its domestic currency then it is more likely to default. This implies that with increasing risk of default, the effective interest rate that foreign investors require will increase, making debt servicing costs increase. As such this creates a situation where the public debt hits a tipping point and the only outcome is default. Any country that denominates its debt in foreign terms has a natural debt curve which, at the peak, has a debt limit. Reinhart and Rogoff (2011b) explores this is some detail; however we turn to Cantore et al. 2017; Bi and Traum 2012, 2014 for a style of logistic functional form for determining the interest rate, hence the debt limit in foreign terms. Therefore, a condition

[1]The NZ Government set a target in the 2017 election of 28% debt to GDP ratio
[2]https://www.gov.uk/government/publications/budget-june-2010

can develop where declining foreign exchange income can be a prelude to a default situation for a government that operates public debt responsibly, if that debt is denominated in foreign currency.

This leads us to the question, why would a government issue public debt in a foreign currency when it has its own domestic currency? Firstly, a legal imposition is that of a currency union, an example of which is the Eurozone. In these cases, countries have made a trade-off between monetary flexibility in managing their fiscal debt, and the benefits of common rule trade. This may be a reasonable deduction in the good times; however, in downturns, the fiscal flexibility that a sovereign currency government has is not available to the country. Our discussion on the historical aspects indicates that some form of transfer between nation states to limit the damage that a public debt default would impose.

Secondly, the economy is so small that it does not have the 'carrying' capacity to hold a level of public debt sufficient for the government's needs. What is a liability to the government is an asset to the private sector. However, if that country's private sector does not have sufficient wealth to buy up the debt, then the government needs to turn to foreign investors. With a small, less stable exchange rate, foreign investors will need to account for exchange rate movements (the classical UIP condition) in the interest rate that they charge. Effectively, a country that is reliant on foreign investors to provide public debt funding, may be forced to denominate its debt in foreign terms and carry the exchange rate risk itself.

Thirdly, although a country may have a sovereign currency, much of its domestic trade and commerce including banking may be undertaken in a foreign currency. A case in point is Argentina prior to the 2000's debt crises, as Na et al. (2014) eloquently illustrates. Although there will be a demand for domestic currency (largely to pay government taxes), private income and wealth will be denominated and held in foreign terms. This is common in many countries where the ubiquitous acceptance of the US dollar for settlement of private transactions leaves the domestic currency to play very much a secondary role. Hence, a country in this situation is not going to be able to 'sell' or service its debt in its domestic currency, necessitating the country to offer debt in foreign terms. Likewise, a country that receives foreign income in foreign currency and needs foreign funds, particularly the private sector, thus diminishing the necessity to use domestic currency, further weakening the domestic currency as of value in foreign exchange.

For the foreign lender to both private and public sectors, they must account for possibility or risk that the household or government may default, customary is to cover the possibility of principle loss by additional interest as an insurance mechanism (Lizarazo, 2013). Such increases result in debt servicing costs which are potentially unsustainable, as already discussed, a tipping point. For the household, this trade-off between defaulting and living with income reduction and that of consumption reduction to service debt brings us to the willingness to repay. If we assume no malfeasances, then this comes down to a simple calculation of maximising the utility. They trade the gain though not having to repay the debt, effectively it being written off and a period of exclusion that impacts the foreign income, the imposition of sanction for a period, for that of a self imposed austerity measure reducing tradable consumption.

Most researcher model public debt in a default situation as a total write-off. As we have already shown, total write-off is rare with recent examples of partial write-off being Greece, Argentina, Brazil and many of the Asian crash countries. In nearly all cases government defaulted on what was due at the time with foreign investors continuing to lend. The first three aforementioned countries did exactly that in 2010, 2002 and 1990 respectively (Chan and Duggar, 2007). In all these cases, they suspended payment of either interest or principle, or both on the bonds that were due at the time. Bar Greece, they entered into Paris Club negotiations to settle the debt with significant haircuts. This model can default to different levels of debt[3] emulating the defaulting process that many countries go though. Any model that does not reflect this reality is questionable as it cannot replicate the repeated sequence of defaulting events that a government in trouble experience. A country may 'limp' from default to default until some accommodation with foreign investors occurs. As Cantore et al. (2017) observes, foreign investors rarely exclude countries that default.

From the investor side, failure to renew debt contracts may result in a much larger default in that, if the country does not receive the funds, then it cannot repay (even partially) other debt. Although USG indicates this is a possibility, they do tend to exclude this from their models. Likewise with the Bi and Traum (2014), default is a one-time event with exclusion. Cantore et al. (2017) is one of the papers to consider the possibility that investors will continue to lend. However, this is in a domestic context and less relevant to foreign investor lending. We observe such behaviour in commercial lending, where investors (banks) will renegotiate the parameters of any such loan contracts rather than forcing default and potentially bankruptcy. Bankruptcy normally resulting in creditors receiving cents on the dollar. By allowing repeating partial defaulting and only returning to good standing when debt becomes sustainable do we model accurately both the foreign investor and government's behaviour. We have a setting that allows for near total default and that demonstrates it is in neither party's interest to go down the road of exclusion as both are likely to loose more wealth and in the case of the country, political stability (Chan and Duggar, 2007).

The overall model derives from foundation model that covers many of the aspects we discuss above. The overall model is highly configurable with different policy and strategy settings that runs in the software suite we set out in Chapter 4. The overall model cover private sector bailouts by the government under certain conditions and a range of defaulting strategies including shallow (defaulting to debt limit), defaulting to affordable and near full default. One aspect to consider is the fiscal policy rule and the application of fiscal policy ideology (or realisation) by the government. With regard to the policy rule, we test scenarios with different weightings for consistency of policy, the effect of national income and stock of public debt to likely extremes where governments may ignore or largely ignore one or more of the inputs to the rule. As to the fiscal policy realisation (that is expansionary or contractionary), taxation, social transfers and government expenditures are set to either be pro-cyclical or countercyclical with the fiscal policy rule. That is, we can simulate extreme austerity or extreme expansionary policies by the government and most cases in between. Furthermore, we provide a partially optimised solution to downward wage rigidity that provide similar results to Na et al. (2014). These

[3] Variable write-offs

mechanisms and factors, when intermixed, provide us with over 11,500 possible scenarios to test form. We select a representative 37 to illustrate the effects of different policy choices on the outcomes for households.

To summarise the foundation model that all the models in this work derive from. The foundation has private and public sectors, with separate default-able debt, trading with both tradable and domestic goods at an exchange rate between them. The private sector has a representative household and firm, the public sector has a government that borrows and a monetary policy agency. All borrowing is with a representative foreign agent that has unlimited resources to lend. Default in the household is on all private debt whereas default in the public sector is limited to what has to be repaid and cannot be funded. The private sector operates a fiscal policy rule that sets the tax rates on consumption and labour income with the expenditures on social transfers and government. Tax rates are pro-cyclical with the fiscal policy rule whereas expenditures are countercyclical representing an mild fiscal expansionary policy on a recession or low levels of public debt. The private sector income streams are from an tradable goods exogenous AR(1) process representing some exportable resource whereas the domestic (non-tradable) good derives from household labour. Labour wage is flexible and unconstrained. The parameter calibration is stock from the various sources as set out in the calibration. The simulation is the foundation simulation we use to benchmark many of the other simulations against.

3.2 The Model

This model has five agents: households and firms in the private sector; Central bank and fiscal government in the public sector and foreign investment agents. Common with the foundations, households receive is an exogenous income stream, labour wages and one period foreign debt to fund consumption and repayment of debt. There are tradable and domestic goods markets with nominal prices and a nominal exchange rate. As with USG, a monetary authority that regulates private sector foreign borrowing. Our extensions include the introduction of a fiscal government that collects proportional tax revenues to fund government consumption and social transfers to households. Government adjust its revenues and expenses by borrowing and repaying from foreign investors with one period bonds. With USG, there is decentralised private borrowing and one centralised default decision. In contrast, this model has decentralised private borrowing and default decision on private debt independent of government with government making its own decision about public debt default. A characteristic of this model is that public and private debt may be priced differently depending on the risk of default.

This model introduces a unobserved fiscal policy rule as a proxy for government policy. This rule takes into account prior policy, current levels of public debt and national income in the determination of government expenditure, social transfers and taxation rates. This introduces a level of stability into the model during normal and recovery periods. In periods when there is a private debt crisis looming, then government makes unanticipated emergency funds through social transfers to households whilst holding . It would fund this by increasing public borrow-

ing from foreign investors. During a crisis it is unlikely that governments are able to substantially increase tax rates or reduce its own expenditures, either of which may exacerbate rather than alleviate the crisis in the private sector. Hence, any measures to return public debt to target levels are ex-post the crisis. This establishes dour distinct periods that maps closely to many economies' behaviour; these being, normality, lead up, crisis, and recovery. Normality where normal economic fluctuations induce changes in consumption and debt. The lead up to a crisis where persistent recessions eventually drive the private sector to default. The crisis where government attempts to prevent private sector default. This may result in the government defaulting and/or private sector default. Finally, recovery, where government attempts to progressively reduce public debt burden and return to normality.

3.2.1 Private Sector

3.2.1.1 Households

There is a continuum of identical households that derive utility from consuming both tradable and domestic (or non-tradable) goods and incur a dis-utility from the labour they supply to firms. Household nominal income sources are from an exogenous stream of tradable goods, a labour wage, social transfers from government, and any profits (or losses) from firms. Households has access to borrowing in foreign currency from foreign agents one period debt at a price that foreign investors will buy dependent on the risk of default. Households pay a proportional taxes on consumption, income and debt to the public sector. The representative household seeks to maximise its instantaneous period discounted utility over its infinite lifetime by solving:

$$U_0 = \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t \left\{ U\left(c_t\right) - H\left(h_t\right) \right\} \tag{3.1}$$

where the utility of total consumption $U\left(c_t\right)$ derives from some function of tradable and domestic consumption:

$$c_t = \Psi\left(c_t^T, c_t^N\right) \tag{3.2}$$

and the dis-utility of household labour is some negative function of labour input $H\left(h_t\right)$.

The nominal household nominal budget constraint in domestic currency terms:

$$\begin{aligned}\left(1+\tau_t^c\right)\left(P_t^T c_t^T + P_t^N c_t^N\right) + \varepsilon_t d_t^H = \left(1-\tau_t^y\right)\left(P_t^T \widetilde{y}_t^T + W_t h_t + \Pi_t\right) \\ + \varepsilon_t \left(1-\tau_t^d\right) q_t^H d_{t+1}^H + P_t^N s_t^N + P_t^T s_t^T + F_t\end{aligned} \tag{3.3}$$

Households receive income, net of tax at rate τ^y, from an exogenous stream of tradable income $\widetilde{y}_t^T$ at tradable goods price P_t^T, income from labour $W_t h_t$, Π_t on domestic production is the time worked, $h_t$at nominal wage W_t and any nominal profits (losses) Π_t. Households also receive a social transfer from the government $P_t^N s_t^N + P_t^T s_t^T$ and a subsidy (or lump sum taxation) F_t from the monetary authority to fund (or levy) household foreign debt. To fund this the monetary

authority levies a proportional tax (or subsidy) on foreign debt $\varepsilon_t \tau_t^d q_t^H d_{t+1}^H$. From production, the household also receives any profits from firms. The household uses the proceeds from income sources, together with the change in debt by repaying debt $\varepsilon_t d_t^H$ and buying new debt $\varepsilon_t \left(1-\tau_t^d\right) q_t^H d_{t+1}^H$ at price q_t^H where the interest rate on household debt is $\left(1+r^H\right) = 1/q_t^H$ and ε_t is the exchange rate.

Household debt is in one of two states, that is continuing to service the debt $I_t^H = 1$ or in default $I_t^H = 0$. Foreign investors exclude households from credit markets, hence:

$$\left(1-I_t^H\right) d_{t+1}^H = 0 \tag{3.4}$$

where $I_t^H \in \{0,1\}$. A household makes the choice between repaying debt in foreign currency $\varepsilon_t d_t^H$ and continuing access to foreign investors or defaulting and not repaying $\varepsilon_t d_t^H$ and forfeits access to credit markets thus $\varepsilon_t \left(1-\tau_t^d\right) q_t^H d_{t+1}^H = 0$. When in good standing and steady state, their exists a trade surplus equivalent to the interest on all foreign debt. Finally, we assume that the transversality condition applies to all debt.

Normalising the Price of Goods The model has two prices P^T, P^N and one exchange ε_t, which we simplify by pricing all goods by the relative price between domestic and tradable goods. Beginning at foreign tradable price, we apply the Law of One Price that implies that the domestic economy is a price taker for tradable goods. Let P_t^{T*}foreign currency price of tradable goods. The domestic price for tradable goods is a conversion from the international price via the exchange rate thus:

$$\frac{P_t^T}{P_t^{T*}} = \varepsilon_t \rightarrow P_t^T = P_t^{T*}\varepsilon_t$$

where ε_t the exchange rate in quality of domestic currency per unit of foreign currency. Again, without loss of generality, normalising the foreign price $P_t^{T*} = 1$ implies nominal tradable goods price is the exchange rate, $P_t^T = \varepsilon_t$. Then the ratio of tradable and domestic goods prices, $p_t = \frac{P_t^N}{P_t^T} = \frac{P_t^N}{\varepsilon_t} \rightarrow p_t\varepsilon_t = P_t^N$ Therefore, we apply this to wages, social transfers, rebates and profits:

$$\begin{aligned}\left(1+\tau_t^c\right)\left(\varepsilon_t c_t^T + p_t\varepsilon_t c_t^N\right) + \varepsilon_t d_t^H = \left(1-\tau_t^y\right)\left(\varepsilon_t \widetilde{y}_t^T + W_t h_t + \Pi_t\right) \\ + \varepsilon_t\left(1-\tau_t^d\right) q_t^H d_{t+1}^H + \varepsilon_t s_t^N + \varepsilon_t s_t^T + F_t\end{aligned}$$

divide by ε_t

$$\begin{aligned}\left(1+\tau_t^c\right)\left(c_t^T + p_t c_t^N\right) + d_t^H = \left(1-\tau_t^y\right)\left(\widetilde{y}_t^T + \frac{W_t}{\varepsilon_t} h_t + \frac{\Pi_t}{\varepsilon_t}\right) \\ + \left(1-\tau_t^d\right) q_t^H d_{t+1}^H + p_t s_t^N + s_t^T + \frac{F_t}{\varepsilon_t}\end{aligned}$$

$w_t = W_t/\varepsilon_t,\ f_t = F_t/\varepsilon_t,\ \pi_t = \Pi_t/\varepsilon_t.$

The household budget (3.3) constraint for tradable and domestics restated with normalisation to one price in foreign and local terms:

$$\begin{aligned}(1+\tau_t^c)\left(c_t^T + p_t c_t^N\right) + \left(1 - I_t^H\right) d_t^H = \left(1-\tau_t^y\right)\left(\widetilde{y}_t^T + w_t h_t + \pi_t\right) \\ + I_t^H\left(1-\tau_t^d\right) q_t^H d_{t+1}^H + p_t s_t^N + s_t^T + f_t\end{aligned} \tag{3.5}$$

The gross inflation rate is the ratio of prices based on the last period. As $p_t = \frac{P_t^N}{P_t^T} = \frac{P_t^N}{\varepsilon_t}$, then the inflation rate for the current period is:

$$\epsilon_t = \frac{\varepsilon_t}{\varepsilon_{t-1}} \tag{3.6}$$

Therefore if ε_t increases (that is, requires more domestic currency to buy one unit of foreign currency, hence the domestic currency depreciates), then P_t^T increases and the ratio of relative price $p_t = {}^{P_t^N}/_{P_t^T}$ decreases. This implies that domestic domestic goods and wages are worth less in foreign currency terms. The domestic currency depreciation results in inflation, ϵ_t.

3.2.1.2 Income, Firms and Production

Continuing with the theme where output derives from an exogenous tradable good, endogenous domestic output from household labour. There are a continuum of identical competitive homogeneous domestic production firms that utilise flexible household labour h_t and remunerate at a nominal rate of W_t wages per unit. They utilise a production technology $F(h_t)$ to produce output domestic domestic output y_t^N.

$$y_t^N = F(h_t) \tag{3.7}$$

As a result, firms make nominal profits derive from the revenue from production less the labour wage cost thus:

$$\Pi_t = P_t^N y_t^N - W_t h_t$$

Firm profits are subject to the wage wage deflation constraint, divide both sides by P^T and $w_t = {}^{W_t}/_{\varepsilon_t}$, $\pi_t = {}^{\Pi_t}/_{\varepsilon_t}$. as above to obtain firms profit in foreign terms:

$$\pi_t = p_t F(h_t) - w_t h_t \tag{3.8}$$

In addition to domestic output, there is a stochastic exogenous endowment stream of tradable goods, y_t^T that can be traded overseas or domestically consumed. The output from this resource is typically persistent, and is subject to exogenous shocks $\epsilon_t^y \sim iid(0,1)$ with a standard deviation of σ^y. These shocks can be liken to terms of trade stocks imposed exogenously or as fluctuations in tradable goods output from domestic resources.When the economy is is good

standing then household obtain the full income from the output, however, when the economy (households or government) is in default, there is an attenuation of output and the household experiences a loss in real income $L\left(y_t^T\right)$.

This loss comes about though the terms of trade and other trading constraints as a result of default, hence:

$$\widetilde{y}_t^T = \begin{cases} y_t^T & I_t = 1 \\ y_t^T - L\left(y_t^T\right) & I_t = 0 \end{cases} \tag{3.9}$$

$$\log y_t^T = \rho_y \log y_{t-1}^T + \sigma^y \epsilon_t^y \tag{3.10}$$

When the economy is in good standing with its debt (both private and public sector) then $I_t = 1$. If either government or household is in default then $I_t = 0$. The assumption is that when either the government or private sector is in default, foreign agents apply more stringent terms of trade that imposes additional costs on the domestic economy, hence a loss during autarky. We refer the reader to Uribe and Schmitt-Grohé (2016, sec. 13.2) for an empirical analysis and discussion on topic output and trade cost of default to an open economy. Continuing from (3.9) implies that:

$$\widetilde{y}_t^T = y_t^T - (1 - I_t)\, L\left(y_t^T\right) \tag{3.11}$$

and the total output for the economy in foreign terms:

$$y_t = p_t F\left(h_t\right) + y_t^T - (1 - I_t)\, L\left(y_t^T\right) \tag{3.12}$$

3.2.2 Public Sector

3.2.2.1 Public Sector Policy and Strategy

The public sector has two functioning organisations, one is an independent monetary authority (referred to as Central Bank, CB) [4] that controls private foreign borrowing through taxation and the other is a fiscal government that attempts to maintain stability through taxation, borrowing and social transfers. We closely model the monetary authority on USG with the same intent, namely, a debt tax that limits household borrowing by creating an pecuniary externality from foreign sources. There is no interaction between monetary authority and public debt.

The fiscal government (government) uses proportional taxation on income and consumption to redistribute as social transfers to households and fund its own expenses, including servicing public debt. Juxtapose to the monetary authority, in normal times the government uses public debt to smooth out tax revenues ensuring that households receive a minimum level of income. This allows a short recession will eventually rebalance itself when followed by an up-cycle. In

[4] Following the doctrine of independent central banks that has become the norm in developed nations and for many developing nations.

contrast, a long and deepening recession can strain public debt with negative secondary deficits that becomes unsustainable in the long run. Likewise, the resilience of the household to long term recession may also make servicing its debt challenging. The government is cognoscente of the current state of the economy and household's income and public debt and sets the tax and expenditures accordingly. As debt is in foreign currency, the government is inter-temporally budget constrained.

3.2.2.2 Monetary Authority

Following the same principles set out in USG, to ensure that households internalise the debt, this model applies the same mechanism; however, it separates the role from the fiscal government. The monetary authority, as part of the public sector, seeks to mange household debt through a debt taxation levying and rebate system. Nevertheless, this model separates household debt and decision making from public sector debt. Nevertheless, its inclusion applies the same logic to maintain consistency with the the foundation models. Restating USG, the monetary authority either taxes external debt sale $q_t^H d_{t+1}^H$ at rate τ_t^d or if:

$$f_t = \tau_t^d q_t^{HD} d_{t+1}^H + \left(1 - I_t^H\right) d_t^H \tag{3.13}$$

The central bank either subsidises the household funded from taxing foreign debt if in good standing $\tau_t^d q_t^H d_t^H$ or alternatively, when in default, sequestrating the household foreign debt payments $\left(1 - I_t^H\right) d_t^H$ and returning it to the household as a subsidy.

3.2.2.3 Fiscal Government

The government operates a budget funded by taxing household income $\tau_t^y \left(\widetilde{y}_t^T + w_t h_t + \pi_t\right)$ and consumption $\tau_t^c \left(c_t^T + p_t c_t^N\right)$ with the proceeds from issuing debt (bonds) d_{t+1}^Gat price q_t^G maturing in the next period. This income then funds government consumption g_t, social transfers $s_t$and repayment of debt(bonds). The government budget constraint stated in international terms:

$$g_t + s_t = \tau_t^c \left(c_t^T + p_t c_t^N\right) + \tau_t^y \left(\widetilde{y}_t^T + w_t h_t + \pi_t\right) + q d_{t+1}^G - \overline{d_t^G} \tag{3.14}$$

where $\overline{d_t^G}$ is a full or partial repayment of current public debt d_t^G. If not in default $d_t^{G*} = d_t^G$ and $I_t^G = 1$, when in default, then partial repayment $\overline{d_t^G} = (1 - \Delta_t) d_t^G$, $I_t^G = 0$ and repays a fraction of the debt Δ_t. Foreign investors continue to lend, however exacting a high price for the debt. As the government consumption and social transfers is in both tradable and domestic goods then:

$$\begin{aligned} g_t^T + p_t g_t^N + s_t^T + p_t s_t^N + \left(1 - I_t^G\right)\left(1 - \Delta^G\right) d_t^G + I_t^G d_t^G = \tau_t^c \left(c_t^T + p_t c_t^N\right) \\ + \tau_t^y \left(\widetilde{y}_t^T + w_t h_t + \pi_t\right) + q_t^G d_{t+1}^G \end{aligned} \tag{3.15}$$

and the primary surplus in foreign terms:

$$\Gamma_t = \tau_t^c \left(c_t^T + p_t c_t^N \right) + \tau_t^y \left(\widetilde{y}_t^T + w_t h_t + \pi_t \right) - (g_t + s_t) \tag{3.16}$$

As we have briefly discussed, households and proportionally taxed on income and consumption to fund government expenditures, social transfers and public debt management. This introduces a problem for the government: if it maintains constant tax rates then (3.15) implies that *ceteris paribus* an increase in debt above the steady state, requires the present value of future secondary surpluses sufficient to cover public debt. We introduce an unobserved government policy instrument that represents the government's one period ahead budget forecast. Most countries operate a budgeting cycle one period ahead to ensure that households, business and foreign investors can adequately plan for any necessary adjustments to tax rates, government expenditures and social transfers proportionately. Furthermore, governments tend to operate at some level of consistency of policy overtime that moderates rapid changes to tax rates and public expenditures. Following Cantore et al. (2017) we adjust taxes on consumption and income proportionately according to the following Taylor type policy rule:

$$\log\left(\frac{\psi_{t+1}}{\psi}\right) = \rho_\psi \log\left(\frac{\psi_t}{\psi}\right) + \rho_\psi^d \log\left(\frac{d_t^G}{d^G}\right) + \rho_\psi^y \log\left(\frac{y_t}{y}\right) \tag{3.17}$$

$$\tau_t^c = \tau^c \psi_t,\ \tau_t^y = \tau^y \psi_t \tag{3.18}$$

Where ψ_t is the government's policy instrument that it uses to determine the adjustments to tax revenues, and government expenditures[5]. ψ,d^G and y are the steady state values for the policy instrument, government debt and national income.The parameters ρ_ψ, ρ_ψ^d, ρ_ψ^y determine the weight that government to debt and income whilst recognising the desire to maintain consistency[6] . A Part of the rebalancing is that when tax rates increase we need to induce a counter cyclical government expenditures to decline. We achieve Cantore et al. (2017) a little more simply by following the same rule (3.18) with government expenditure and the inverse of the policy instruments:

$$g_t = \frac{g}{\psi_t} = \frac{p_t g^N}{\psi_t} + \frac{g^T}{\psi_t} \tag{3.19}$$

where g is the steady state level derived from the underlying tradable and domestic goods consumed by government, as hence $p_t g^N + g^T = g, \quad g^N, g^T > 0$. Therefore the proportion of government consumption of either tradable or domestic goods is dependent on the tradable price of domestic goods whereas the policy instrument increases or reduces the overall level of government consumption proportionally for tradable and domestic goods.

[5]We deviate from Cantore et al. (2017) slightly in that we later specify that government expenditures adjustment is by the same mechanism.

[6]Inspection of table 1 in Cantore et al. (2017) the coefficients of debt and output are 0.0777, 0.1478 for tax and 0.1197, 0.1624 for government with 0.6252 for the persistence of tax rates and a 0.7662 persistence of government expenditures. We therefore estimate the model using the same techniques in Cantore et al. (2017) for one equation and three dependent variables, namely consumption and income tax rates, and government expenditure level. Of course, the policy instrument is unobserved however the tax rates, public debt and national income are all observed.

Social transfers (funding) covers activities that government undertakes to improve households such as healthcare, welfare and security. Naturally, if household choose to use transfers for consumption then the government receives tax revenue. This is not the case if households choose to use transfer for debt. Social transfers s_t are a combination of tradable and domestic goods funded by tax revenues and debt. We assume that during periods leading up to a crisis, transfers are always positive, that is not a lump sum tax. A countercyclical policy would compensate a decline in national income with greater social transfers. We achieve this from 3.17, in the term $\rho_\tau^y \log\left(\frac{y_t}{y}\right) < 0$ (recessionary) and social transfers being governed the inverse of fiscal instrument $\frac{s^T}{\psi_t}$. However, is attenuated by high levels of public debt, that is $\rho_\tau^d \log\left(\frac{d_t^G}{d^G}\right) > 0$. We observe social transfers (though welfare) increase particularly at the beginning of a recession and potentially taper off as government's (households, and foreign investors) become increasingly concerned about the level of public debt (Mukherjee and Bhattacharya, 2010). Formally, when government is in a social funding status transfers are:

$$s_t = \frac{s^T}{\psi_t} + p_t s_t^N, \quad s_t^N, s_t^T \geq 0 \,\forall t \tag{3.20}$$

3.2.3 The Foreign Sector's Pricing of Public and Private Debt

An important difference in this research is that we treat private and public sector debt as separate and only linked only by the mechanism of tax revenues and terms of trade loss in default. The foreign sector investors are risk neutral and buy household $d_{t+1}^H$and government d_{t+1}^G debt at prices q_t^H and q_t^G. Naturally, price setting accounts for the risk of default and the international rate of interest r^*. For the household,the foreign investors assess the willingness to repay the debt or default. However, for government, foreign investors assess the political will and ability to repay the debt. By treating the criteria for assessing probability of default differently, then the effective interest rate for private and public sectors may be different depending on the level of their respective indebtedness and the risk they pose to defaulting. In many countries, private and public sector debt interest rates are significantly different. We observe in some cases private debt may be at a lower interest rate that public debt depending on the indebtedness. We cater for such circumstances by independently determining the price of public and private sector debt. Therefore the foreign investors offer to buy debt from private and public sectors at a price that makes them indifferent between the investments accounting for the risk of default.

There are a number of instances where the government has defaulted and the private sector has continued to borrow from foreign investors, albeit at significantly detrimental terms. We cope with this by setting the attenuation of production if either sector is in default.An important mechanism in either private or public debt default is that the economy experiences a loss (3.11) in terms of trade represented by a loss function. This loss continues whilst foreign investors exclude either or both households and government from access to financial markets depending on who has defaulted. A private sector default may cause the government to loose tax revenue, consequentially affect the ability of the government to service its debt. Likewise,

when government defaults, the private sector looses tradable income and may affect its ability to service debt or its willingness to repay debt. We assume that government will continue to service debt whilst it can continue to finance servicing through tax revenue and borrowing and only limited by its ability to impose austerity at a later date.

3.2.3.1 Private Sector

For the private sector, foreign lenders charge q_t^H when in both private are in good standing setting the domestic market rate q_t^{HD}hence by no-arbitrage condition, $q_t^H = q_t^{HD}$. When in default, then domestic borrowers and lenders clear and set q_t^{HD}accordingly. The price of private debt is therefore a function of the probability default in the next period, given that private sector is in good standing[7], that isPr $\left(I_{t+1}^H = 1 \mid I_t^H = 1\right)$. When divided by the gross international interest rate provides us with a price that risk neutral foreign investors would purchase private debt at as:

$$q_t^H = \frac{\Pr\left(I_{t+1}^H = 1 \mid I_t^H = 1\right)}{1 + r^*} \tag{3.21}$$

Representing a interest rate $r_t^H = \frac{1+r^*}{\Pr\left(I_{t+1}^H = 1 | I_t^H = 1\right)} - 1$. The participation in debt markets implies $\left(q_t^H = q_t^{HD}\right)$ in good standing, therefore the participation constraint on domestic price to international price is:

$$I_t^H \left(q_t^{HD} - q_t^H\right) = 0 \tag{3.22}$$

and with (3.21) and (3.22) is equivalent to:

$$I_t^H \left[q_t^H - \frac{\mathrm{E}_t\left(I_{t+1}^H\right)}{1 + r^*}\right] = 0 \tag{3.23}$$

This implies that $\Pr\left(I_{t+1}^H = 1 \mid I_t^H = 1\right) = \mathrm{E}_t\left(I_{t+1}^H\right)$ when in good standing. As foreign investors exclude private sector from borrowing then in default there is no foreign debt:

$$\left(1 - I_t^H\right) d_{t+1}^H = 0 \tag{3.24}$$

3.2.3.2 Government Sector

We adopt a different approach to government following Davig (2004); Bi and Traum (2014); Bi, Leeper and Leith (2014) with the default dependent on the effective government debt limit d_t^{G*}. Government repays its debt in full, if the current level of debt is below the effective government debt limit. In any other circumstance, it defaults, formally:

$$I_t^G = \begin{cases} 1 & d_t^G < d_t^{G*} \\ 0 & d_t^G \geq d_t^{G*} \end{cases} \tag{3.25}$$

[7]Later, we define private sector default probability as the value of continuing to service debt and the value of being in default, formally:Pr $\left\{v^{gc}\left(d_{t+1}^H, y_{t+1}, h_{t+1}\right) \geq v^d\left(y_{t+1}, h_{t+1}\right) | y_t, I_t^H = 1\right\}$

Where the stochastic debt limit ,$d_t^{G*}$is drawn from a exogenous distribution, $d_t^{G*} \sim D^{G*}$ that is non-linear in that it rapidly rises once the probability of default starts to rise. Further discussion on these points can be found in Bi and Traum (2014); Cantore et al. (2017). We express the debt limit cumulative density using a logistic function with two parameters with calibrations from the data. The probability of default, ϕ_t that is the probability of $I_t^G \rightarrow 0$ given that the government is not in default, is:

$$\phi_t^G = \Pr\left(d_t^G \geq d_t^{G*}\right) = \frac{\exp\left(\eta_1 + \eta_2 d_t^G\right)}{1 + \exp\left(\eta_1 + \eta_2 d_t^G\right)} \tag{3.26}$$

where η_1 and η_2 are parameters that derive from lower and upper two points on the logistic cumulative distribution, $\left(d^L, \phi^L\right)$ and $\left(d^U, \phi^U\right)$ thus:

$$\eta_1 = \log\left(\frac{\phi^L}{1-\phi^L}\right) - \eta_2 d^L, \quad \eta_2 = \frac{1}{d^L - d^H}\log\left(\frac{\phi^L}{\phi^H}\frac{1-\phi^H}{1-\phi^L}\right) \tag{3.27}$$

We reserve discussion how to calibrate and estimate $\left(d^L, \phi^L\right)$ and $\left(d^H, \phi^H\right)$ later to ensure that d_t^{G*} is consistent with the public debt limit $d_{nld}^G$and the politically tolerable maximum of fiscal instrument ψ_{gs}. For any given level of government debt d_t^G, the default probability is ϕ_t that represents the risk premium over the gross international interest rate $1 + r^*$. Hence, the determination of the price of public debt the probability of not defaulting in the next period:

$$q_t^G = \frac{\mathrm{E}_t\left(1\text{-}\phi_{t+1}\right)}{1 + r^*} \tag{3.28}$$

Combining 3.26 with 3.28 provides a price that foreign investors are willing to offer:

$$q_t^G = \frac{\mathrm{E}_t\left[1\text{-}\frac{\exp\left(\eta_1+\eta_2 d_{t+1}^G\right)}{1+\exp\left(\eta_1+\eta_2 d_{t+1}^G\right)}\right]}{1 + r^*} \tag{3.29}$$

The government's demand for debt d_{t+1}^G at the price the foreign investors are willing to offer derives primary surplus (or deficit) and the current level of public debt, hence:

$$d_{t+1}^G \left\{ \frac{\mathrm{E}_t\left[1\text{-}\frac{\exp\left(\eta_1+\eta_2 d_{t+1}^G\right)}{1+\exp\left(\eta_1+\eta_2 d_{t+1}^G\right)}\right]}{1 + r^*} \right\} = \overline{d_t^G} - \Gamma_t \tag{3.30}$$

and solving for d_{t+1}^Gprovides the next period public debt level. If government defaults on public debt then they repay:

$$\overline{d_t^G} = \left(1 - I_t^G\right)\left(1 - \Delta^G\right) d_t^G + I_t^G d_t^G \tag{3.31}$$

Where $\Delta^G$is of the debt being defaulted on. Partial repayment reflects the nature of public debt, namely it has a maturity structure and default is normally on only some part of the debt. Although exclusion does occur and there is imposition of sanctions, that reduces immediately tradable income for the economy.

3.2.4 Market Clearing and Competitive Equilibrium

In this section, we cover the market clearing conditions for tradables and domestics followed by the competitive equilibrium. This then allows the specification of the rest of the model that includes the motivation by government to to make bailout payments, the decision making of households and. consequentially the debt dynamics.

3.2.4.1 Market Clearing

The economy wide budget constraint derives from (3.5), (3.15), (3.13) and (3.12) where the proceeds from tradable and domestic output, the change in private and public sector debt funds all the consumptions (government and household) and the servicing of debt we express as:

$$\begin{aligned} c_t^T + p_t c_t^N + g_t^T + p_t g_t^N =& y_t^T - (1 - I_t) L\left(y_t^T\right) + \\ &+ F(h_t) + I_t^H \left(q_t^H d_{t+1}^H - d_t^H\right) + q_t^G d_{t+1}^G - \left[1 - I_t^G (1 - \Delta)\right] d_t^G \end{aligned} \tag{3.32}$$

The domestics market clears in equilibrium when:

$$c_t^N + g_t^N = y_t^N \tag{3.33}$$

$$c_t^N + \frac{g^N}{\psi_t} = F(h_t) \tag{3.34}$$

and from (3.32) implies that the tradable market clear when:

$$c_t^T + g_t^T = y_t^T - (1 - I_t) L\left(y_t^T\right) + I_t^H \left(q_t^H d_{t+1}^H - d_t^H\right) + q_t^G d_{t+1}^G - \left[1 - I_t^G (1 - \Delta)\right] d_t^G \tag{3.35}$$

Therefore a combination of tradable output and foreign debt is fully funds all tradable consumptions (private and government) and any debt service costs.

3.2.4.2 Competitive Equilibrium

Households Households seek to maximise utility by choosing consumptions (tradable and domestic), labour supply, and level of household, given that government sets the the tax rates for consumption and income and the social transfers, the monetary authority sets the tax rate for foreign debt and any subsidy. Therefore state that the problem as:

$$\max_{\left\{c_t^T, c_t^T, h_t, d_t^H\right\}} U_0 = \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t \left\{ U\left(\Psi\left(c_t^T, c_t^N\right)\right) - H\left(h_t\right) \right\} \tag{3.36}$$
$$- \lambda_t \left[\left(1+\tau_t^c\right)\left(c_t^T + p_t c_t^N\right) + d_t^H \right]$$
$$+ \lambda_t \left[\left(1-\tau_t^y\right)\left(\widetilde{y}_t^T + w_t h_t + \pi_t\right) + \left(1-\tau_t^d\right) q_t^H d_{t+1}^H + s_t + f_t \right]$$

Where the Lagrange multiplier:

$$\lambda_t = {}^{H_{h_t}(h_t)}/_{\left(1-\tau_t^y\right)w_t} = {}^{U_c\left(\Psi\left(c_t^T, c_t^N\right)\right)\Psi_1\left(c_t^T, c_t^N\right)}/_{\left(1+\tau_t^c\right)} = {}^{U_c\left(\Psi\left(c_t^T, c_t^N\right)\right)\Psi_2\left(c_t^T, c_t^N\right)}/_{p_t\left(1+\tau_t^c\right)}$$

Price of non-traded divide to obtain:

$$p_t = \frac{\Psi_2\left(c_t^T, c_t^N\right)}{\Psi_1\left(c_t^T, c_t^N\right)} \tag{3.37}$$

Labour supply for a given wage:

$$\frac{H_h\left(h_t\right)}{w_t} = \frac{\left(1-\tau^y \psi_t\right)}{\left(1+\tau^c \psi_t\right)} U_c\left(\Psi\left(c_t^T, c_t^N\right)\right)\Psi_1\left(c_t^T, c_t^N\right) \tag{3.38}$$

Euler equation for tradables sector:

$$\left(1-\tau_t^d\right) q_t^H \lambda_t = \beta \mathrm{E}_t \lambda_{t+1} \tag{3.39}$$
$$1 = \frac{\beta}{\left(1-\tau_t^d\right) q_t^H} \frac{\left(1+\tau^c \psi_t\right)}{\mathrm{E}_t\left(1+\tau^c \psi_{t+1}\right)} \frac{\mathrm{E}_t U_c\left(\Psi\left(c_{t+1}^T, c_{t+1}^N\right)\right)\Psi_1\left(c_{t+1}^T, c_{t+1}^N\right)}{U_c\left(\Psi\left(c_t^T, c_t^N\right)\right)\Psi_1\left(c_t^T, c_t^N\right)} \tag{3.40}$$

Euler equation for domestic sector:

$$\frac{\mathrm{E}_t p_{t+1}}{p_t} = \frac{\beta}{\left(1-\tau_t^d\right) q_t^H} \frac{\left(1+\tau^c \psi_t\right)}{\mathrm{E}_t\left(1+\tau^c \psi_{t+1}\right)} \frac{\mathrm{E}_t\left[U_c\left(\Psi\left(c_{t+1}^T, c_{t+1}^N\right)\right)\Psi_2\left(c_{t+1}^T, c_{t+1}^N\right)\right]}{U_c\left(\Psi\left(c_t^T, c_t^N\right)\right)\Psi_2\left(c_t^T, c_t^N\right)} \tag{3.41}$$

Firms and Production As stated previously, the firms problem is to maximise profit π_t:

$$\max_{\{w_t, h_t\}} \pi_t = p_t F\left(h_t\right) - w_t h_t$$

that leads to using FOC wage setting:

$$p_t F_h\left(h_t\right) = w_t \tag{3.42}$$

Private Sector (households and production) Combining (3.37) and(3.42) to obtain:

$$p_t = \frac{\Psi_2\left(c_t^T, c_t^N\right)}{\Psi_1\left(c_t^T, c_t^N\right)} = \frac{w_t}{F_h\left(h_t\right)} \tag{3.43}$$

$$\tag{3.44}$$

From labour, wage and consumption (3.38) and (3.43):

$$\frac{H_h\left(h_t\right)}{F_h\left(h_t\right)} = \frac{\left(1-\tau^y\psi_t\right)}{\left(1+\tau^c\psi_t\right)} U_c\left(\Psi\left(c_t^T, c_t^N\right)\right)\Psi_2\left(c_t^T, c_t^N\right) \tag{3.45}$$

This represents normal the trade-off between labour dis-utility, the marginal production of labour and the marginal utility of domestic consumption, taking into account the government's fiscal policy.

Government The market clearing conditions (3.33) and (3.35) then impose on the government budget constraint:

$$\frac{g^N}{\psi_t} + s^N = \tau^c\psi_t c_t^N + \tau^y\psi_t F\left(h_t\right) \tag{3.46}$$

$$\begin{aligned}\frac{1}{\psi_t}\left(g^T + s^T\right) + I_t^G d_t^G = {} & \tau^c\psi_t c_t^T + \tau^y\psi_t\left[y_t^T - \left(1-I_t\right)L\left(y_t^T\right)\right] \\ & + q_t^G d_{t+1}^G - \left[1 - I_t^G\left(1-\Delta_t\right)\right] d_t^G\end{aligned} \tag{3.47}$$

With (3.33), (3.46) implies that primary surplus from domestics is zero. However, tradables, has debt, therefore the primary tradables surplus:

$$\begin{aligned}\Gamma_t^T &= \tau^c\psi_t c_t^T + \tau^y\psi_t\left[y_t^T - \left(1 - I_t^G I_t^H\right)L\left(y_t^T\right)\right] - \frac{1}{\psi_t}\left(g^T + s^T\right) \\ &= \left[1 - I_t^G\left(1-\Delta_t\right)\right] d_t^G - q_t^G d_{t+1}^G\end{aligned} \tag{3.48}$$

Next, consider the default and bailout decisions of both households and public sector regarding their debt.

3.2.4.3 Households Decision on Debt

Households consider the option of continuing to service the household debt with foreign investors, that is being in good standing and continuing or defaulting, that is in bad financial standing. When households default they experience two immediate effects, the loss of tradable income and exclusion from financial markets. We consider the household's decision as a recursive maximisation (dynamic programming) problem using three core Bellman equations

representing the value of being; good standing and remaining so, in default, and finally, the choice between the two.

Under market clearing conditions(3.34) and (3.35) in equilibrium, then the household considers the options of continuing to service debt and repay debt or defaulting. We analyse the decision of the household by turning the infinite horizon problem (3.36) into a dynamic programming problem where the household makes decisions on consumptions, labour input and the level of debt. We restate the problem in three parts, value of being in good standing and remaining so, the value of default and then the decisions between defaulting and remaining in good standing. The value of being in good standing and continuing:

$$v^{gc}\left(d_t^H, y_t^T, \hat{h}_t, \psi_t\right) = \max_{\left\{c_t^T, c_t^N, h_t, d_{t+1}^H\right\}} \left\{U\left(\Psi\left(c_t^T, c_t^N\right)\right) - H(h_t) + \beta E v^g\left(d_{t+1}^H, y_{t+1}^T\right)\right\} \tag{3.49}$$

subject to

$$c_t^T = \frac{\left(1-\psi_t\tau^y\right)y_t^T + q_t^H d_{t+1}^H - d_t^H + \frac{s^T}{\psi_t}}{1+\psi_t\tau^c}$$

$$c_t^N = F(h_t) - \frac{g^N}{\psi_t}$$

$$\frac{H_h(h_t)}{F_h(h_t)} = \frac{\left(1-\psi_t\tau^y\right)}{\left(1+\psi_t\tau^c\right)} U_c\left(\Psi\left(c_t^T, c_t^N\right)\right)\Psi_2\left(c_t^T, c_t^N\right)$$

However, households may default and need to consider the value of default noting that they may return to good standing with probability θ^H, hence the value of defaulting:

$$v^d\left(y_t^T, \hat{h}_t, \psi_t\right) = \max_{\left\{c_t^T, c_t^N, h_t\right\}} \tag{3.50}$$

$$\left\{U\left(\Psi\left(c_t^T, c_t^N\right)\right) - H(h_t) + \beta E_t\left[\theta^H v^g\left(d_{t+1}^H, y_{t+1}^T, \hat{h}_{t+1}, \psi_{t+1}\right) + \left(1-\theta^H\right)E v^d\left(y_{t+1}^T, \hat{h}_{t+1}, \psi_{t+1}\right)\right]\right\}$$

subject to

$$c_t^T = \frac{\left(1-\psi_t\tau^y\right)\left[y_t^T - L\left(y_t^T\right)\right] + \frac{s^T}{\psi_t}}{1+\psi_t\tau^c}$$

$$c_t^N = F(h_t) - \frac{g^N}{\psi_t}$$

$$\frac{H_h(h_t)}{F_h(h_t)} = \frac{\left(1-\psi_t\tau^y\right)}{\left(1+\psi_t\tau^c\right)} U_c\left(\Psi\left(c_t^T, c_t^N\right)\right)\Psi_2\left(c_t^T, c_t^N\right)$$

When the household defaults, then tradable consumption is reliant on the revenue from the attenuated tradable output, social transfers less tax on output and consumption. . This implies $c_t^T = y_t^T - L\left(y_t^T\right) - g^T$ The value of being in good standing is a choice between value of continuing in good standing and the value of defaulting:

$$v^g\left(d_t^H, y_t^T, \hat{h}_t, \psi_t\right) = \max\left\{v^{gc}\left(d_t^H, y_t^T, \hat{h}_t, \psi_t\right), v^d\left(y_t^T, \hat{h}_t, \psi_t\right)\right\} \tag{3.51}$$

therefore the default indicator $I_t^H$is set by:

$$I_t^H = \underset{m\in\{0,1\}}{\text{argmax}} \left\{ m v^{gc}\left(d_t^H, y_t^T, \hat{h}_t, \psi_t\right) + (1-m)\, v^d\left(y_t^T, \hat{h}_t, \psi_t\right)\right\} \tag{3.52}$$

3.2.4.4 Model Solution

A competitive equilibrium for the set of stochastic processes $\left\{c_t^T,\, c_t^N,\, h_t,\, \hat{h}_{t+1},\, w_t,\, d_{t+1}^H,\, \lambda_t,\, q_t^H,\, q_t^{dH},\, \psi_t,\, d_{t+1}^G,\, \overline{s_t^T}\right\}$satisfying:

$$\begin{aligned}(1+\tau^c\psi_t)\, c_t^T + = (1-\tau^y\psi_t)\left[y_t^T - \left(1 - I_t^G I_t^H\right) L\left(y_t^T\right)\right] \\ + I_t^H\left(q_t^H d_{t+1}^H - d_t^H\right) + \frac{s^T}{\psi_t} + \left(1 - I_t^{H*}\right)\overline{s_t^T}\end{aligned} \tag{3.53}$$

$$c_t^N = F(h_t) - \frac{g^N}{\psi_t} \tag{3.54}$$

$$\lambda_t = \frac{U_c\left(\Psi\left(c_t^T, c_t^N\right)\right)\Psi_1\left(c_t^T, c_t^N\right)}{(1+\tau^c\psi_t)} \tag{3.55}$$

$$\left(1-\tau_t^d\right) q_t^{dH}\lambda_t = \beta \mathrm{E}_t\lambda_{t+1} \tag{3.56}$$

$$\frac{H_h(h_t)}{F_h(h_t)} = \frac{(1-\tau^y\psi_t)}{(1+\tau^c\psi_t)} U_c\left(\Psi\left(c_t^T, c_t^N\right)\right)\Psi_2\left(c_t^T, c_t^N\right) \tag{3.57}$$

$$p_t = \frac{\Psi_2\left(c_t^T, c_t^N\right)}{\Psi_1\left(c_t^T, c_t^N\right)} \tag{3.58}$$

$$w_t = p_t F_h(h_t) \tag{3.59}$$

$$0 = \left(1 - I_t^H\right) d_t^H \tag{3.60}$$

$$0 = I_t^H\left(q_t^{dH} - q_t^H\right) \tag{3.61}$$

$$0 = I_t^H\left[q_t^H - \frac{\mathrm{E}_t\left(I_{t+1}^H\right)}{1+r^*}\right] \tag{3.62}$$

$$\begin{aligned}\frac{1}{\psi_t}\left(g^T + s^T\right) + \left(1 - I_t^{H*}\right)\overline{s_t^T} = \psi_t\left\{\tau^c c_t^T + \tau_t^y\left[y_t^T - (1-I_t)\, L\left(y_t^T\right)\right]\right\} \\ + d_{t+1}^G - \left[1 - I_t^G(1-\Delta)\right] d_t^G\end{aligned} \tag{3.63}$$

$$q_t^G = \frac{\mathrm{E}_t\left[1\text{-}\frac{\exp\left(\eta_1+\eta_2 d_{t+1}^G\right)}{1+\exp\left(\eta_1+\eta_2 d_{t+1}^G\right)}\right]}{1+r^*} \tag{3.64}$$

$$\log\left(\frac{\psi_{t+1}}{\psi}\right) = \rho_\psi \log\left(\frac{\psi_t}{\psi}\right) + \rho_\psi^d \log\left(\frac{d_t^G}{d^G}\right) + \rho_\psi^y \log\left(\frac{y_t}{y}\right) \tag{3.65}$$

given the processes $\left\{y_t^T, \epsilon_t, \tau_t^{dH}, \overline{h_t}, I_t^H, I_t^G, I_t^{H*}, \overline{s_t^T}\right\}$and under initial conditions $\left\{d_0^H, d_0^G\right\}$.

3.3 Functional Form, Calibration and Computation

These calibrations, the strategies for public sector default and bailout of the private sector with the fiscal policy realisation setting and the flexible/rigidity wage/exchange rate form the *found-*

ation scenario. We then run the scenario against the mathematical model that is encoded in software that we describe in Chapter 4. We refer to the mathematical model with the basic settings that we have described here as the *foundation model*. We separate the scenario from the model so that we can create multiple different scenarios against the same model without having to change the underlying software. This allows us to extensively test the model implementation and then be able to calibrate it against a country or groups of countries.

3.3.1 Calibration

The calibrations for the foundation scenario are from Na et al. (2014) using the Argentine economy over the period of the 2002 default. These are generally accepted as a reasonable calibrations for this type of model. The fiscal policy rule derives from Cantore et al. (2017) their initial experiments. A list of the calibrations and sources is in tables Table 3.1 and Table 3.2.

Param	Value	Description	Source
β	0.85	Household discount factor	Na et al. (2014)
α	0.75	Labour share in non-traded	Na et al. (2014)
γ_c	0.26	Tradables share of consumption	Na et al. (2014)
σ	2	Inter-temporal elasticity of consumption	Na et al. (2014)
χ	0.5	The dis-utility of labour factor	Na et al. (2014)
φ	0.25	elasticity of marginal dis-utility of labour supply	Uribe and Schmitt-Grohé (2016)
ξ	0.5	elasticity of substitution between goods	Na et al. (2014)
γ_w	0.99	Downward wage rigidity	Na et al. (2014)
r^*	0.01	International interest rate	Na et al. (2014)
θ^H	0.0385	Probability of returning to good standing	Na et al. (2014)
y^T	1	Steady state tradable output	Na et al. (2014)
ρ_y	0.9317	Persistence of exogenous log tradable output	Na et al. (2014)
σ^y	0.037	SD. of shocks to tradable output	Na et al. (2014)
δ_0	0	Output lost function intercept	Na et al. (2014)
δ_1	-0.35	Output lost function linear parameter	Na et al. (2014)
δ_2	0.4403	Output lost function quadratic parameter	Na et al. (2014)

Table 3.1: Initial Calibrations - Private sector

These calibrations form the basis for all of the parameters in the foundation scenario. In addition, there is a *no bailout* strategy by the government on private sector defaults[8] and if the government defaults then it will default to the maximum level of debt that it can purchase[9]. In addition, the private sector wages are and exchange rates are fully flexible with no constraint[10], and the fiscal realisation[11] is moderately expansionary generating pro-cyclical taxation and counter-cyclical social transfers and government expenditures.

[8]Further discussion on bailouts is in Chapter 6

[9]We discuss alternative strategies in Chapter 7

[10]We discuss in Chapter 8

[11]This is the way that the fiscal policy rule is translated into the tax rates, social transfers and government expenditures. We discuss this further in Chapter 8

Param	Value	Description	Source
ρ_ψ	0.6252	Fiscal policy persistence	Cantore et al. (2017)
ρ_ψ^d	0.0777	fiscal policy sensitivity to public debt deviations	Cantore et al. (2017)
ρ_ψ^y	0.1478	fiscal policy sensitivity to output deviations	Cantore et al. (2017)
$g^T + g^N$	0.2	Steady state total government expenditure	Uribe and Schmitt-Grohé (2016)
τ^c	0.05	Steady state consumption tax rates	Cantore et al. (2017)
τ^y	0.24	Steady state labour tax rates	Cantore et al. (2017)
$s^T + s^N$	0.2	Steady state social transfers	Uribe and Schmitt-Grohé (2016)
η_1	see text	Govt debt Logistic function parameter	calculated
η_2	see text	Govt debt Logistic function parameter	calculated
Δ	calculated	Government debt haircut rate	Cantore et al. (2017)
d^L	1.6	Logistic- low end public debt level	Bi and Traum (2014)
ϕ^L	0.3	Logistic- low end public debt default probability	Bi and Traum (2014)
d^H	1.8	Logistic- high end public debt level	Bi and Traum (2014)
ϕ^H	0.99	Logistic- high end public debt default probability	Bi and Traum (2014)

Table 3.2: Initial Calibrations - Government

3.3.2 Functional forms

The functional forms follow those in Uribe and Schmitt-Grohé (2016) permitting us to use the calibrations from that source. We set a CRRA period utility function for consumption with an CES aggregator function to combine tradable and domestic consumption. Similarly, for labour dis-utility of labour hours detracts from total utility:

$$U\left(c_t\right) = \frac{c^{1-\sigma}}{1-\sigma} \tag{3.66}$$

$$H\left(h_t\right) = \chi \frac{h^{1+\varphi}}{1+\varphi} \tag{3.67}$$

$$c_t = \Psi\left(c_t^T, c_t^N\right) = \left[\gamma_c \left(c^T\right)^{\frac{\xi-1}{\xi}} + \left(1-\gamma_c\right)\left(c^N\right)^{\frac{\xi-1}{\xi}}\right]^{\frac{\xi}{\xi-1}} \tag{3.68}$$

$$U\left(c_t\right) = \frac{\left[\gamma_c \left(c^T\right)^{\frac{\xi-1}{\xi}} + \left(1-\gamma_c\right)\left(c^N\right)^{\frac{\xi-1}{\xi}}\right]^{\frac{\xi(1-\sigma)}{\xi-1}}}{1-\sigma} \tag{3.69}$$

$$U\left(c_t, h_t\right) = \frac{\left[\gamma_c \left(c^T\right)^{\frac{\xi-1}{\xi}} + \left(1-\gamma_c\right)\left(c^N\right)^{\frac{\xi-1}{\xi}}\right]^{\frac{\xi(1-\sigma)}{\xi-1}}}{1-\sigma} - \chi \frac{h^{1+\varphi}}{1+\varphi} \tag{3.70}$$

Production is for the domestics sector and follows the form:

$$F\left(h_t\right) = A h_t^{\alpha} \tag{3.71}$$

The loss function for on the exogenous stream of tradable output, y_t^T:

$$L\left(y_t^T\right) = \max\left(0,\, \delta_0 + \delta_1 y_t^T + \delta_2\left(y_t^T\right)^2\right) \tag{3.72}$$

Following on from the competitive equilibrium in equations (3.53) to (3.65) incorporating the functional forms leads to:

$$\begin{aligned}(1+\tau^c\psi_t)\,c_t^T + = (1-\tau^y\psi_t)\left[y_t^T - \left(1 - I_t^G I_t^H\right) L\left(y_t^T\right)\right] \\ + I_t^H\left(q_t^H d_{t+1}^H - d_t^H\right) + \frac{s^T}{\psi_t} + \left(1 - I_t^{H*}\right)\overline{s_t^T}\end{aligned} \tag{3.73}$$

$$c_t^N = A h_t^{\alpha} - \frac{g^N}{\psi_t} \tag{3.74}$$

$$\lambda_t = \frac{\gamma_c\left(c^T\right)^{-\frac{1}{\xi}}\left[\gamma_c\left(c^T\right)^{\frac{\xi-1}{\xi}} + (1-\gamma_c)\left(c^N\right)^{\frac{\xi-1}{\xi}}\right]^{\frac{1-\sigma\xi}{\xi-1}}}{(1+\tau^c\psi_t)} \tag{3.75}$$

$$\left(1-\tau_t^d\right) q_t^{dH}\lambda_t = \beta \mathrm{E}_t\lambda_{t+1} \tag{3.76}$$

$$\frac{\chi h^{\varphi}}{\alpha A_t h_t^{\alpha-1}} = \frac{(1-\tau^y\psi_t)}{(1+\tau^c\psi_t)}(1-\gamma_c)\left(c^N\right)^{-\frac{1}{\xi}}\left[\gamma_c\left(c^T\right)^{\frac{\xi-1}{\xi}} + (1-\gamma_c)\left(c^N\right)^{\frac{\xi-1}{\xi}}\right]^{\frac{1-\sigma\xi}{\xi-1}} \tag{3.77}$$

$$p_t = \frac{(1-\gamma_c)\left(c^T\right)^{\frac{1}{\xi}}}{\gamma_c\left(c^N\right)^{\frac{1}{\xi}}} \tag{3.78}$$

$$w_t = p_t \alpha A h_t^{\alpha-1} \tag{3.79}$$

$$0 = \left(1 - I_t^H\right) d_t^H \tag{3.80}$$

$$0 = I_t^H\left(q_t^{dH} - q_t^H\right) \tag{3.81}$$

$$0 = I_t^H\left[q_t^H - \frac{\mathrm{E}_t\left(I_{t+1}^H\right)}{1+r^*}\right] \tag{3.82}$$

$$\begin{aligned}\frac{1}{\psi_t}\left(g^T + s^T\right) + \left(1 - I_t^{H*}\right)\overline{s_t^T} = \psi_t\left\{\tau^c c_t^T + \tau_t^y\left[y_t^T - (1-I_t)\,L\left(y_t^T\right)\right]\right\} \\ + d_{t+1}^G - \left[1 - I_t^G(1-\Delta)\right] d_t^G\end{aligned} \tag{3.83}$$

$$q_t^G = \frac{\mathrm{E}_t\left[1\text{-}\frac{\exp\left(\eta_1+\eta_2 d_{t+1}^G\right)}{1+\exp\left(\eta_1+\eta_2 d_{t+1}^G\right)}\right]}{1+r^*} \tag{3.84}$$

$$\log\left(\frac{\psi_{t+1}}{\psi}\right) = \rho_\psi \log\left(\frac{\psi_t}{\psi}\right) + \rho_\psi^d \log\left(\frac{d_t^G}{d^G}\right) + \rho_\psi^y \log\left(\frac{y_t}{y}\right) \tag{3.85}$$

3.3.3 Computation

The following summarises the computational process to construct the various tables and policy rules that we use to simulate a sequence. A detailed explanation of the software environment is in Chapter 4 showing in detail the building of all of the state transition matrices, the dynamic programming and heuristic learning tools to identify patterns particularly in crisis events. This

includes a classification tool that analyses the path of the data to find crisis events either in public or private sector to identify the sequence of states that the crisis goes though to build a hierarchical map of the events with classifications and sub-classes.

The heuristic event classification system looks for events that are is very close proximity and ties them together to construct an event sequence. This is then classified by its common sequence features to provide an event sequence classification. These are then summarised and presented as time path sequences. Items in brackets are data stores eg. (PR) is the policy rule data store[12]. We summarise the computational process as follows:

1. Compile all the Model (MP) and Program (PP) parameters to construct a set of static structured data (SD) that forms the basis of the state transitions (PR) for each variable path.

2. Compute the $AR(1)$ process for log of tradable output using equation (3.10) with normally distributed innovations in output. Out initial calibrations for the parameters derive from USG and are specified in Table 3.1 . This generates a time-series which then forms the basis of computing a discrete state transition with equally spaced points for $\log y_t^T$ distributed between $\pm 4.2\sigma^y$. Given the calibrations, the unconditional standard deviation is $\frac{\sigma^y}{\left(1-\rho_y^2\right)^{0.5}} = 0.102$[13]. The process for creating a Markov state model is to count the transitions from y_t^T (rows) to y_{t+1}^Tin a matrix (countable state space) $\forall t$ starting at $t = 0$. After counting the all the transitions, calculate the probabilities by totalling the rows and dividing each element in the row by the total of that row. This forms the foundation for running the simulations.

3. Construct the equilibrium dynamics for the government policy rule (PR). This creates discrete three dimensional array that represents the state transitions for the government fiscal policy rule. This then determines the tax, social transfers and government expenditures, which later feeds into the equilibrium dynamics for the household.

4. Complete the government budget constraint and debt borrowing requirements. This also includes calculating the state transition for current levels of debt, the primary surplus (deficit) and the new level of debt. The calculation of the logistic function to calculate the price of debt is included in this state transition. This finalises in a decision array that takes into account, tax income, expenditure, hence primary surplus with the current levels of debt to determine new level of debt, or the decision by the government to not fully repay the debt. In this foundation model the government will repay as much debt as it can fund from its own primary surplus and new debt to cover interest payments and principle.

5. Construct the state space for the domestic component. This again feeds into the equilibrium dynamics for the household.

6. Using value-function iteration in a dynamic programming algorithm to capture equilibrium dynamics in a discrete state space for every level of private debt, household income

[12] Full definitions are in Chapter 4

[13] $\frac{0.037}{(1-0.9317^2)^{0.5}}$

and fiscal policy rule setting (PR). This provides the basis to calculate the households willingness to repay or default decision array. This provides the transition probability matrix that forms the basis calculating private sector default probabilities and the equilibrium policy rules.

7. After some tidying up and cross checking, we run a the stochastic process to generate sequences for y_t^T and the return to good standing for the household and government. This allows us to run different policy settings on the same sequence to observe the effects of the policy settings. These sequences have a burn in period to ensure that some form of stability within the simulation occurs before recording the run. This forms the basis for running the stimulations and further analysis.

8. A simulation run (SR) produces a sequence path for each variable as a set of indices to the matrix. Furthermore, we capture discrete events such as default, reason for default (or bailout in one of the extensions), the returning to good standing. We refer to this as a scenario dependent on the policy settings that is the foundation for the analysis that follows

9. Next is to run the analysis tools that identify the discrete events and determine if there is a sequence to them (QR). It applies pre-determined rules to identify the integrity of a sequence. Once it identifies a sequence, it then classifies it by the discrete events that make it up and matches that classification with other classifications either identified in this simulation or others. If there is no near classification then it creates a new one. These event sequences are then standardised and held in a indexed sequential hierarchical structure that allows quick referencing of similar event sequences by their classification.

10. The reporting (RR) includes distributions of the characteristics of classified events, the statistical analysis of classifications of time sequences to produce representative graphs of each variable during that event sequence. Furthermore, a range of statistical analysis reports completes the analysis of one simulation sequence.

11. Future analysis and reporting between different scenarios allows us to observe the effects of changing different parameters or rules on government, household, foreign investors and the economy in general.

3.4 Simulation Results for the Foundation Scenario

This foundation scenario combines the basic parameters from both Schmitt-Grohé and Uribe 2016b and Cantore et al. 2017 in table 3.4. The fiscal policy parameters are directly from Cantore et al. (2017) that drives the hidden fiscal policy rule variable ψ for the next period. This determines the tax rates, government expenditures and social transfers in both tradable and domestic sectors. Therefore the fiscal policy rule modifies household behaviour in the next period. . The tax rates and Households, if they default, default on all of their debt whereas government will

State space parameter	specification
State space points y^T	200
Simulation y^T	30mn
Burn in	0.1mn
State Transition matrix size	200x200
Public debt range	0-2
Private debt range	0-2
Grid points for all discrete variables	200
Fiscal instrument range	0.36-1.44
general tolerance on dynamic programming	10^{-9}

Table 3.3: State Space Computational specifications

Scenario feature	Settings
Scenario mnemonic	MMM_HCDL_NOB_FW_EXP
fiscal Policy Rule parameters	$\rho_\psi = 0.6252$,$\rho^d_\psi = 0.0777$, $\rho^y_\psi = 0.1478$ (MMM)
Government debt haircut rule	Haircut to debt limit to limit (HCDL)
Bailout rule	No Bailouts (NOB)
Wage setting rule	Flexible Wages and floating exchange rates (FW)
Fiscal policy	Pro-cyclical tax rates generating pro-cyclical tax revenues, counter-cyclical social transfers and government expenditures. That is an expansionary policies in lower tax rates and increase government expenditures and social transfers when the fiscal policy rule is in the lower range. (EXP)

Table 3.4: Foundation Scenario parameter settings that govern the simulation.

haircut their debt to the maximum level they can bare within their budget constraint and the revenue from sale of new debt. We report in the possible ranges for core government sector variables in table 3.5. Summary statistics are in the appendix for all the main variables of concern in both the normal state, where there is no sanctions, and the sanctions state where either the government or household have triggered a default and sanctions are in place for the period.

Inspection of figure Figure 3.1 illustrates the loss function. The quadratic function clearly shows that once tradable income exceeds 0.8, then the loss function increasingly attenuates the income (red line). Therefore if sanctions are in place and the economy is recovering, the loss function has the effect of increasingly holding back the economy until there is relief from them.

Next is to consider the government debt supply given the current level of debt and the interest rate. We calculate the interest rate with the logistic function set out in section 3.2.3.2. We illustrate the exponential effect of increasing level of debt in interest rate in Figure 3.2a. This is similar to that found in Bi and Traum (2012). At peak, the interest rate is >10%. If one refers to Figure 3.2bthen one can observe that this is approaching the natural peak that approximates to 0.94 D/long run GDP. This forms the Natural debt limit for the government d^G_{ndl}. This comes about as the revenue from issuing new debt is priced at less than par to account for the interest.

Variable	min	mean	max
ψ	0.3928	0.900	1.3659
τ^C	0.0197	0.045	0.0681
τ^Y	0.0946	0.216	0.3269
g^T	0.2284	0.100	0.0661
g^N	0.2284	0.100	0.0661
s^T	0.2537	0.111	0.0734

Table 3.5: From the above scenario parameter settings and the overall parameters, the fiscal policy variables have the above ranges. By changing the fiscal policy rule parameters, these variables change their range and median point.

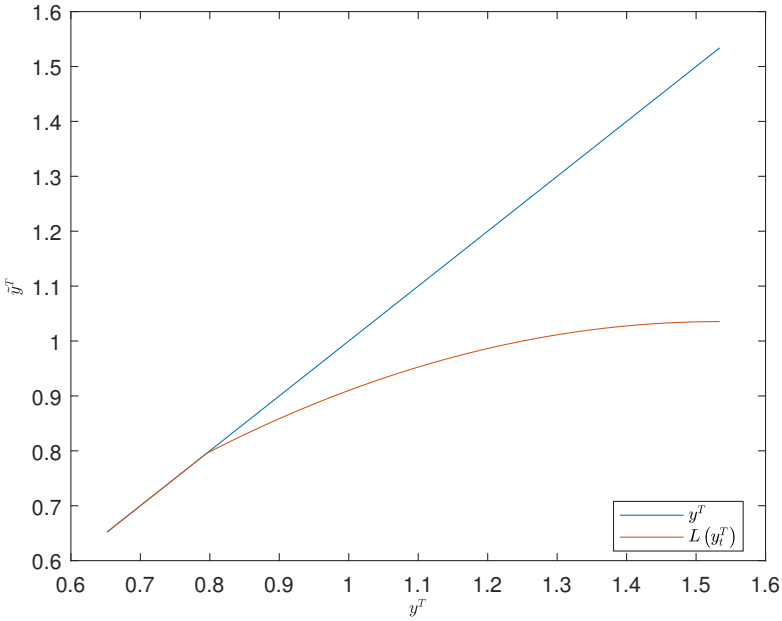
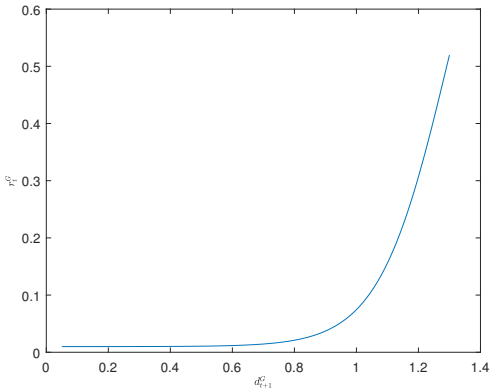


Figure 3.1: Tradeable Output Blue line without sanctions, red line (lower), sanctions. Therefore of any given level of y^T(x axis) there is an equivalent $\tilde{y}^T$and depending on the state (normal or sanctions), the loss attenuates the possible tradeable income when in sanctions.

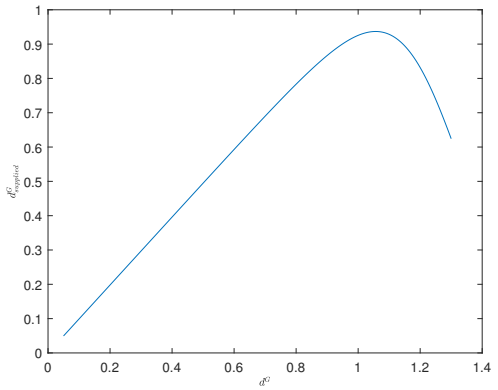
At the peak, the revenue from selling 1.06 of debt is 0.94 in revenue. Clearly, this becomes unsustainable unless the government runs significant primary surpluses. We observe a tipping point some way before the peak, that without intervention or substantial increases in revenue, the government is almost certain to default and require a haircut on the debt. Although in this model, the total debt is cycled every period, we simulate partial default by hair-cutting the difference between what debt sold and the natural debt limit. The demand is less than supply, driving a haircut in debt being bought back. This scenario creates the more normal circumstance where government default only on what is due for excise at that time and is likely to continue to default until debt falls well below the natural debt limit..

One aspect that we show later is that governments in that we simulate a sequence of government default on debt over varying time-periods. In studying default sequences, particularly of developing nations, then clear observation of repeated defaulting by the government until some accommodation is achieved with foreign investors. This is somewhat more realistic that

the normal government debt modelling where all debt is defaulted on and the government starts 'afresh'.



(a) Interest rates on next period public debt

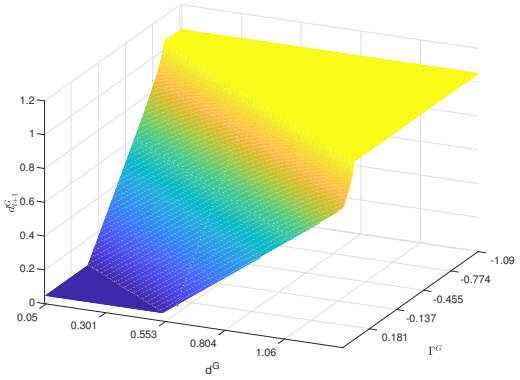


(b) Public debt supplied and next period debt level

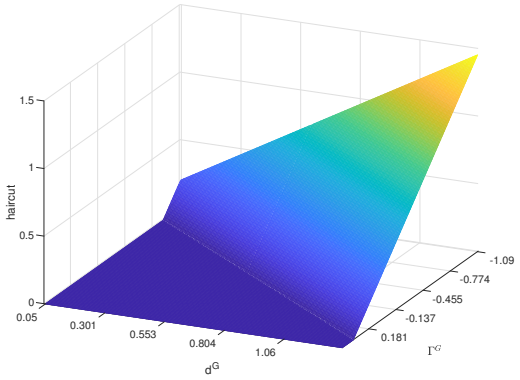
Figure 3.2: Public debt supply and government interest rates on tradeable public debt

Following this interpretation, then we represent a three dimensional form of Figure 3.2b that includes the primary surplus Γ^G in Figure 3.3a. Therefore, for any given current debt level and primary surplus then reading from the vertical line that intersects the plane provides the new level of debt is in the vertical axis. However, exceeding the debt limit necessitates haircutting which we illustrate in Figure 3.3b. The fold line in this chart corresponds to the peak of the next period debt, effectively flattening the new level though haircutting at that peak. This in turn affects the fiscal policy rule though the debt term in the equation in the next period. Therefore, haircutting ripples though, first the debt in the next period, and then the fiscal policy in the period following. As the debt is at the limit, the fiscal policy rule variable will increase; that in turn increases taxation and decreases government expenses. This follows the pattern where governments default, then attempt to address the situation by progressively apply emergency measures in the subsequent budgets, sometimes at the direction of foreign investors or international non-government organizations.

To illustrate the effects of being in default on the the economy, if we study Figure 3.4 it shows graphically the difference between the good or normal state (GD) and the bad or sanctions state (SA) for the key variables for all event sequences. We observe that $\tilde{y}^T$ decline representing the implementation of sanctions, however, has little effect on domestic GDP, y^N either to compensate for that decline. Therefore, total GDP y declines when sanctions occur. The effects on consumption c^T and c^N mirror that of GDP in the tradable and domestic sectors. However, we observe a decline in wages w with a commensurate decline in price p. One of the impacts of a recession is deflationary pressure on domestic goods. With debt, the expectation is that with the imposition of sanctions, household debt would decrease; in part the government policy rule response is to implement austerity, increasing tax and decreasing expenditure in response to its



(a) Debt In next period. The current level of debt d^Gless the primary surplus $\Gamma^G$is the level of public debt demand government can only purchase $q_t^G d_{t+1}^G$bonds where $d_{t+1}^G < d_t^G$ as $q_t^G < 1$. This imposes a maximum level of debt and the government will need to haircut repayment of d_t^G



(b) Haircut occur when government has insufficient revenue from the primary surplus Γ^G and new debt sales $q_t^G d_{t+1}^G$ to repay the current debt d_t^G. Haircuts can never be greater than the current level of debt as long as they can continue to borrow.

Figure 3.3: The Policy strategy for debt management, Haircut to debt limit (HCDL) means that the government will only default on the part of the debt where it cannot obtain sufficient funds from the primary surplus and the sale of new debt.

own debt increase. Furthermore, the household's tradable income stream is markedly lower, therefore debt becomes less affordable and the response to these pressures by the household is to generally lower its debt. We observed a debt unwinding in the private sector and an increase in public debt as the economies were in turmoil post the 2008 financial crash. The increasing risk that government represents in these sanction period passes though the the interest rate $r^G$with a marked increase in debt servicing costs. Likewise, the opposite occurs for the household as it deleverages. Although there is no central bank controlling domestic interest rates, it customary for the Central bank to rapidly drop interest rates in response to a crisis. Hence, we would observe the sanction periods where interest rates would be substantially less. Finally, the total stock of debt d is substantially higher during sanction periods largely driven by government borrowing requirements.

3.4.1 Event classifications and analysis

The simulation run produces a series of discrete events according to the event classifications in Chapter 4. The event classifications are pre-determined at the discrete level single event; however, sequences of events are heuristically analysed to determine sequence classifications. A complete list of discrete events and sequence classifications for all scenarios is in Chapter 4. However, for this foundation scenario, there are two discrete one period events; namely government defaults (**GDEFx**) and Household default (**HDNBx**) without a bailout[14]. Table 3.6 shows both the summary level and discrete events. The summarisation is that the first event classification followed by the second different event classification can be summarised to a

[14]This is to differentiate between failed attempt to bailout and government refusing to bail out

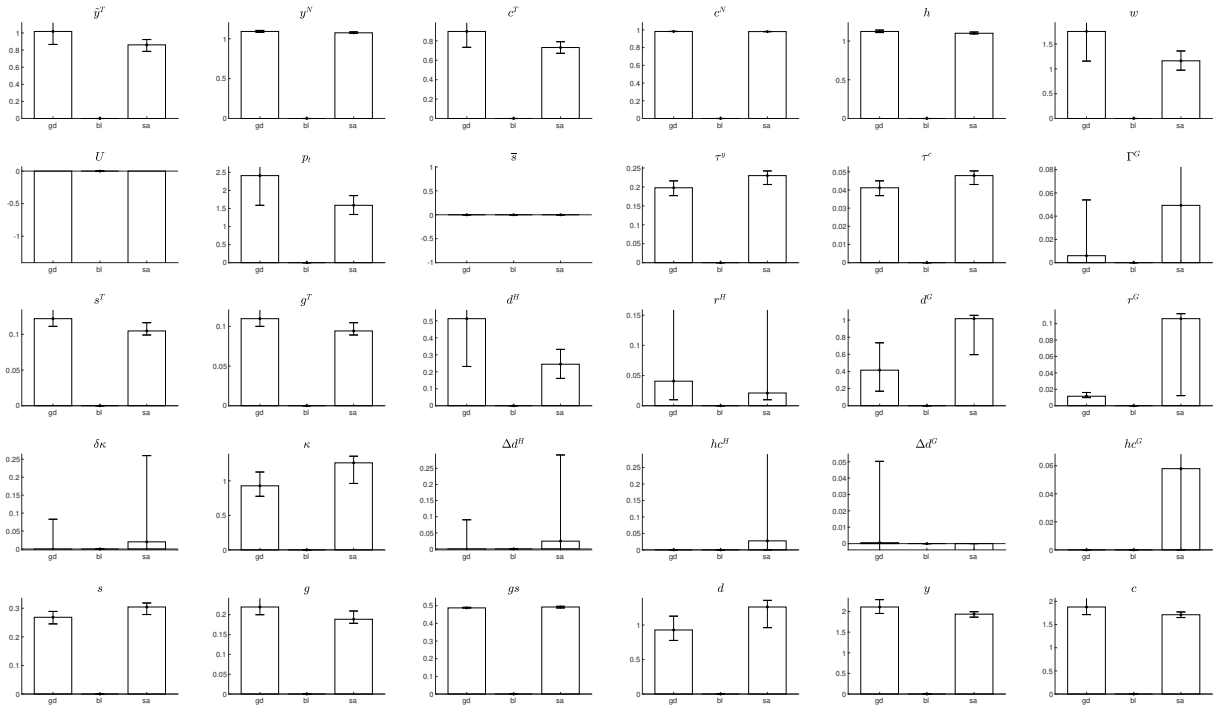


Figure 3.4: Summary statistics for Foundation when in *Good*, *Bad* and *Sanctions* states

group classification. For example, all event sequences that start with Government (**GDEFx**) are grouped into **GDEFA**.

identity	Description
ALLxx	All events
GDEFA	All events starting with a government default
GDEFx	Government defaults
HDNBA	All events starting with a No bailout, the household defaults
HDNBx	Government does not bailout the household and it defaults

Table 3.6: List of all of the one period events with their descriptions

Referring to Table 3.7 government initiated default (**GDEFA**) counts both government only (**GDEFx**) and government followed by household (**GDEFx.HDNBx**) event sequences. The searching and classification process identifies 27,734 event sequences of which 6,638 are government initiated default and 21,096 are private sector initiated a near 3 to 1 ratio. In Chapter 2, private sector defaults are much more prevalent that government defaults in the developed world and, in many cases, the developing world reinforcing that the foundation model and scenario follows closely the real world. Note that the sequence classification household followed by government (**HDNBx.GDEFx**) indicates that the private sector defaults that leads to a situation where the government ends up defaulting as well.

Event Sequence Classification	Event sequences
ALLxx	27734
GDEFA	6638
GDEFx	6104
GDEFx.HDNBx	409
HDNBA	21096
HDNBx	19882
HDNBx.GDEFx	1115

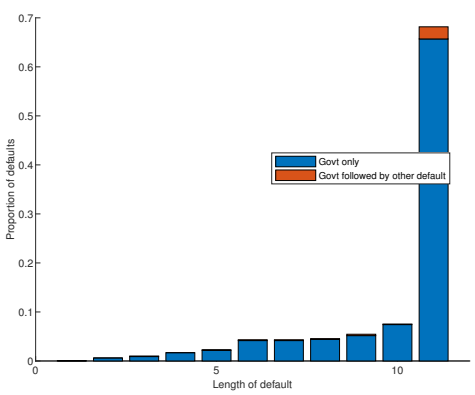
Table 3.7: Under different scenarios, a summary of the combinations of one period events (taking into account only the first two unique events) and number of occurrences

The sudden decline in government taxation revenue though the imposition of sanctions on the private sector, and the inability of the government to raise taxes fast enough drives the public debt up to unsustainable levels.The government continues to service part of the debt, haircutting the result and therefore partially able to function with time to implement austerity measures in the form of increasing taxation with reducing social transfers and government expenditures. Unfortunately, these measures, or just the current economic conditions, may eventuate in the private sector defaulting subsequent to the government default. In this foundation simulation, this is a rare event sequence. Another aspect is that government default leading to household default (**GDEFx.HDNBx**) occur 50% less that private sector default leads to government default (**HDNBx.GDEFx**). The model follows the illustrative historical and empirical analysis where, contrary to the economic literature, it is the private sector that drives most of the crises.

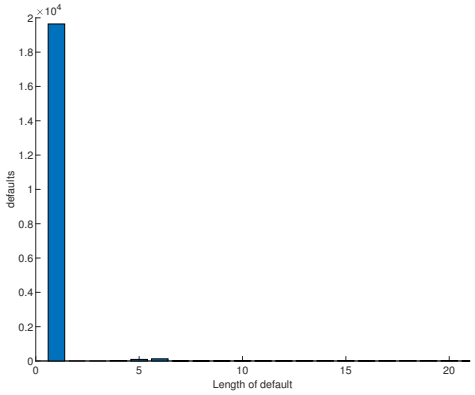
3.4.2 Length and cost of default

Although the raw counts in association with the classifications may give some insight into crisis sequences, they do not portray how long they last. Focusing on the distribution of defaults, Figure 3.5a government default sequences tend to be ten periods plus. This closely follows the data where countries will be in default and continue to default on their debt until some negotiation with foreign investors though the Paris Club or some fundamental shift in economic circumstances occurs. Note that private sector default only occurs following a public sector default when there are long sequences of default.

The next is to consider the cost of defaulting to the foreign investor for both household and government defaults. We note that from Figure 3.5a, most default sequences are small and there is a long tail where some rare default sequences involve multiple default events with a long accumulative cost to the foreign investor. This aligns with the data, in that default sequences tend to be short period events with a partial, rather than a full default.



(a) Distribution number Government initiated defaults by the length of the default.



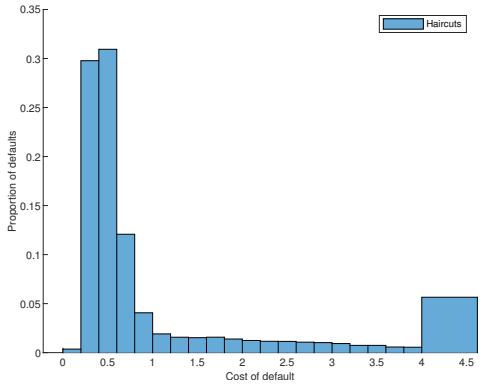
(b) Distribution Non Government initiated defaults by the length of the default

Figure 3.5: Comparison of the length of default.

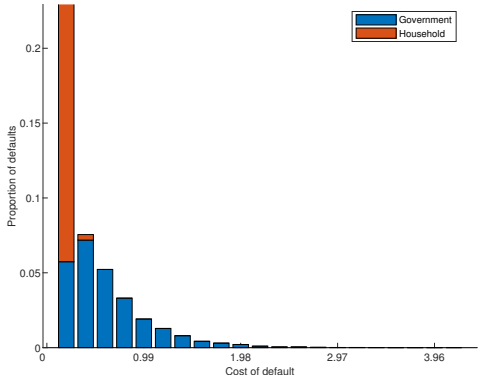
The data indicates some countries remain in default for some time and will continue to haircut debt until a successful negotiation between county and investors. The set up of this foundation scenario implies that household default would occur once only and then experience a period of sanctions, whereas government may experience some sanctions but will continue to default until it reaches a point of debt stability. In Figure 3.5b, we observe that household default short lived rather than the much longer lived government defaults in Figure 3.5a. This is somewhat akin to the 2008 financial crisis where the banking system collapse was short lived, however their was a long tail to the consequences.

Greece and Iceland are a case in point; in the case of Iceland, the banking system was nationalised at a nominal value, the toxic assets were written off and the government took on the burden of reinflating the banking system. An aspect of Iceland is that they have their own sovereign currency, although small in comparison, and they issue domestic currency debt that they are able to service without default. The counter example without a sovereign currency is Greece; once they resolved the private sector banking problem, much to the relief of the German banks, their debt ballooned and they defaulted multiple times. In the case of Greece, the loss in taxation revenue would have made their debt unsustainable. This reasonably fits with the data on default sequences with other countries, particularly for those in the Asian crisis and the south American default episodes, where private sector tended to be short lived and public sector defaults have a propensity to continue until a resolution is found. The longer the sequence, the more costly it is for foreign investors. However, we are consistent with the data in that majority of defaults are small in comparison to the level of debt, even though public debt default tends to be long lived.

The next to consider is the distribution of costs of defaulting events. Figure 3.6 indicates on the left hand chart that the costs are skewed to the lower end for all default events. However, there is a long tail (indicated by 4+ zone on the distribution) of very costly long events, however rare.



(a) Distribution costs of all defaults



(b) Distribution costs of Government and Household defaults to foreign sector

Figure 3.6: Costs of default, haircuts to foreign sector

The right hand chart provides a breakdown of which type of default is causing the costs. This indicates that household defaults tend to be low cost but very frequent whereas government defaults are more costly, but less frequent. One aspect of this scenario is that the household debt tends to be small, much like the middle and low income countries rather than high income countries. This means the threshold for default is also quite low making the cost of default small, but more frequent. When the household defaults, it writes off all the debt, therefore it is unlikely to repeat a default within sequence. In this scenario, governments can accumulate substantial debt and as they haircut to the debt limit, this tends to cause multiple defaults very close together in the sequences. This also tends to accumulate significant costs for the foreign investor motivating them to enter into negotiations quickly.

3.4.3 Crises Event Sequence Analysis

Although the characteristics of the frequency and cost are of some importance, the time sequence of key variables for a crisis may give some insight into how to forecast such an event. After running the simulation with the classification tool-sets which categorize the crisis sequences, we standardise the the timeline, centring on either the start of the event sequence or the point which a default, private or public, occurs. We can then find the mean path and the confidence interval around that path. We do this for all applicable event sequence classifications: in this case **ALL**, **GDEFA** (public sector initiated default sequences) and **HDNBA** (private sector initiated default sequences). **GDEFA** and **HDNBA** are subsets of **ALL**[15]. As the stochastic process y^T drives the process we would expect that $\tilde{y}^T$ to be in decline prior to any crisis as we illustrate in Figure 3.7. This chart covers all events (both public and private) over the course of the simulation. It is centred on the time of default and covers all crises event sequences. The crisis point is zero and we include 10 periods prior and 10 periods post.

First, looking at the default event itself, and its affects, on private debt d^H and public debt d^G in conjunction with the private haircutting hc^H and public haircutting. hc^G As expected, private

[15] Chapter 4 and the classification appendix illustrate the different sequence classifications with an explanation of their meaning

debt declines slowly before the crises in response to lowering income. and then there is a default event generating a haircut in the private sector. The haircut tends to be for one period, and household debt tends to recover afterwards with the recovery of tradable income $\tilde{y}^T$. Note that there is a step change in tradable income at the default point representing the imposition of sanctions. Although in this model that step change may recover, the 2008 financial crisis shows that sometimes that step change is much more persistent, and may never revert[16].

As to public debt, prior to the crisis, the decline in tax revenues whilst maintaining high levels of expenditure g put the country into a primary deficit Γ^G. This primary deficit generates additional government debt d^G up until the crisis point. Although we will discuss separately public default vs that of private sector default later. Some interesting aspects of the default sequence we can deduce here that resembles the paths that many countries take in a public debt default. Note that the haircutting hc^G is persistent whilst declining immediately after default. Furthermore, the interest rates r^G are at near their peak as public debt remains troublesome to both the country and foreign investors, whereas private debt interest rate collapses to near zero lower bound, something we observe in developed economies in the central bank's response to the crisis. Although there is a substantial climb in public debt interest rates, peaking sometime after the default event, these start to decline slowly inline with the haircutting. An example of this behaviour is Greece for the period immediately after the 2010 default event, where bond yields made much of Greece's debt unaffordable.

In the domestic sector with domestic goods we observe a slow recession y^N,however not to the same extent as tradables. As this simulation is a flexible wage model, wages take the hit from the recession with a marked decline driven largely by price. Still, there is an impact on employment with a decrease in labour demand h following any crisis event. One could consider the domestic sector as fundamentally essential to sustain living conditions, in Keynesian terms, C_0providing a baseline level of consumption with little change c^N. We will show later the effects of a downward wage rigidity on employment where effectively the roles of labour demand and wages are reversed to some extent.

The focus on the domestic sector fits with the narrative that many governments offer after a crisis, that is they focus inwardly. In this economy, the government response is to cut government expenditures g whilst increasing social transfers. The scenario dictates that as ψ, the fiscal policy rule variable, is increasing in response to the level of government debt, that social transfers would decline much the same way as government expenditure would g. The fiscal policy rule only affects tradable social transfers s^T,not domestic social transfers s^N. They are the residual from tax revenues less the government expenditure[17]. The apparent uplift in social transfers is the government switching from tradable goods funding to domestic goods funding of social programmes; likening this to governments, during crises, need to fund benefits to households to sustain them though the crisis. This compensates for the loss of income to the household from labour wage so that they can maintain a base level of consumption.

One aspect of this scenario is the clear lagging of government fiscal policy responses to the

[16]Unfortunately, an aspect of this model is that it has a long run equilibrium, thus will eventually return to that equilibrium

[17]in the domestic sector government expenditure derives from the fiscal policy rule

crises. Although governments need to direct additional funds to social transfers, they do that in an environment where sudden jumps in tax rates and immediate austerity in government programmes would not necessarily be tolerated in the middle of a crisis by the population. The need for consistent policy with a more deliberate rather than knee-jerk reaction though the budgeting process reflects the path of our hidden fiscal rule policy variable ψ. Furthermore, the imposition of increasing taxes and declining government sector expenditure is normally driven by foreign investors and international NGO's driving fiscal responsibility in line with the doctrine of neoclassical doctrine.

Although inspecting the the conglomerate of event sequences has some use, isolating down to the two sequence classes may give a better understanding of how the economy behaves in the face of a private sector or public sector default sequence. Important questions here are: What are the effects on tradable and domestic sectors during a default of ether the private or public debt? What drives the differences between the two?

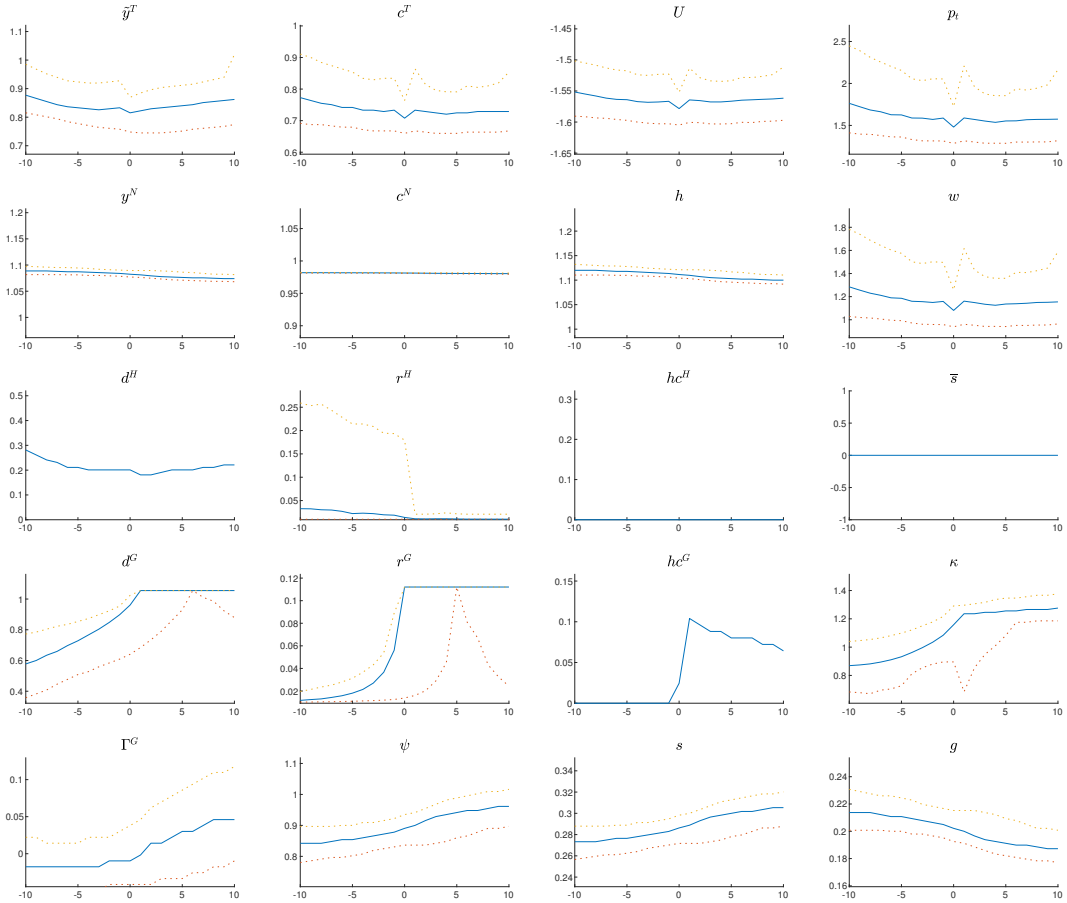


Figure 3.7: All events sequences aligned on default

Already we know that there are three times as many private sector initiated crisis sequences compared with those initiated by public sector. An important aspect of these models is the separation of public and private debt and, although they indirectly affect each other, they do so though the mechanisms in the economy. This is somewhat more realistic than the assumptions normally portrayed in the literature, where many crises in both developing and developed

countries stem from a failure in the private sector and not the government. This model aligns with Chapter 2 empirical evidence that private sector creates more instability than the public sector in an economy .

Starting with the public sector, inspection of Figure 3.8 (for **GDEFA** classifications) confirms much of the analysis above; that is a general decline in tradable income induces a decline in tax revenues and, through the budgeting process, the government is unable to respond fast enough to prevent a crisis. Although the government does start to respond (fiscal policy variable ψ climbs) it is insufficiently quick enough to address the primary deficit, Γ^Guntil it is too late. The rapid increase in government debt forces up interest rates, hence debt service costs, making the shortfall even worse. Hence government debt hits a tipping point where hair-cutting $hc^G$is the only possible outcome. There is a small step change in tradable income y^Treflective of the one period sanctions. This ripples though the household with a sharper decline in tradable consumption. However, the government, through social transfers, maintains domestic consumption in the face of declining wages. Private debt declines in line with that of tradable income, with a gradual return post crisis.

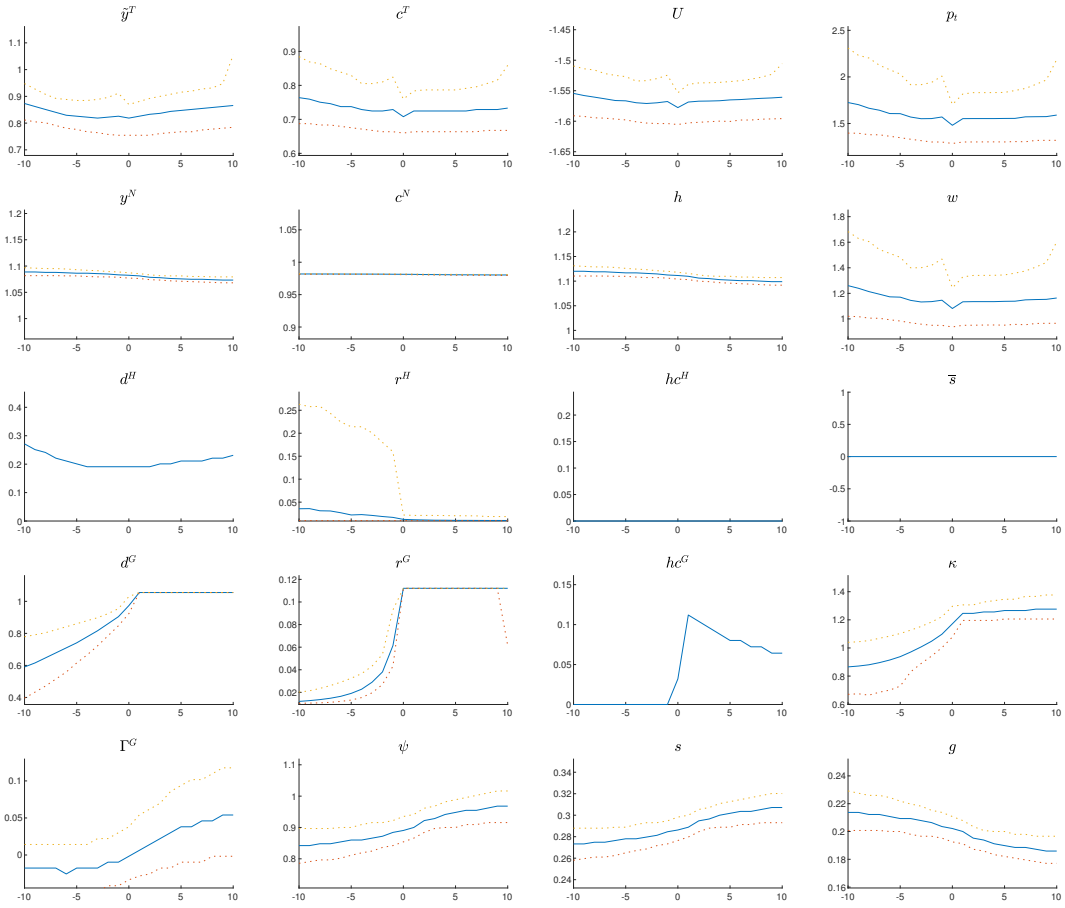


Figure 3.8: Government default sequences aligned on the default

The government is trapped in haircutting, as are the foreign investors. If, for any reason, foreign investors do not coordinate (as they do though the Paris Club), then the government will be forced to default on all its debt as it comes due. Foreign investors, particularly Banks and

other financial institutions, need to maintain the asset value, otherwise accounting rules (mark to market) dictate writing off substantial assets putting them in jeopardy. This scenario demonstrates this behaviour and has close alignment to that of Greece and Argentina public debt and the financial institutions that fund them.

Prior to the crisis, private sector interest rates $r^H$are high in comparison to that post crisis and do not follow the same path as the level of private debt. At the crisis point, tradable income starts to increase and with the fall in debt level prior to the crisis, the risk of household default is minimal. In this simulation, the likelihood of a public sector default triggering a private sector default is minimal (a probability less than 0.07). In the case of a public sector default, households are minimally disrupted by the default even if government conduct sufficient social transfers post crisis. Government in this case is preventing a crisis in the public sector spilling over into the private sector. Without those social transfers, domestic consumption would collapse and, if one follows the Post-Keynesian doctrine that effective demand drive employment, then their would be a collapse in the labour market either though wages or though unemployment. Hence, the domestic social transfers act as a stabilizer to the domestic sector. Government consumption of domestic goods reduces as a result of the fiscal policy rule ensuring that government does not crowd out private consumption. By transferring those funds to the household, it stabilises the household's base level of consumption whilst domestic output is in decline.

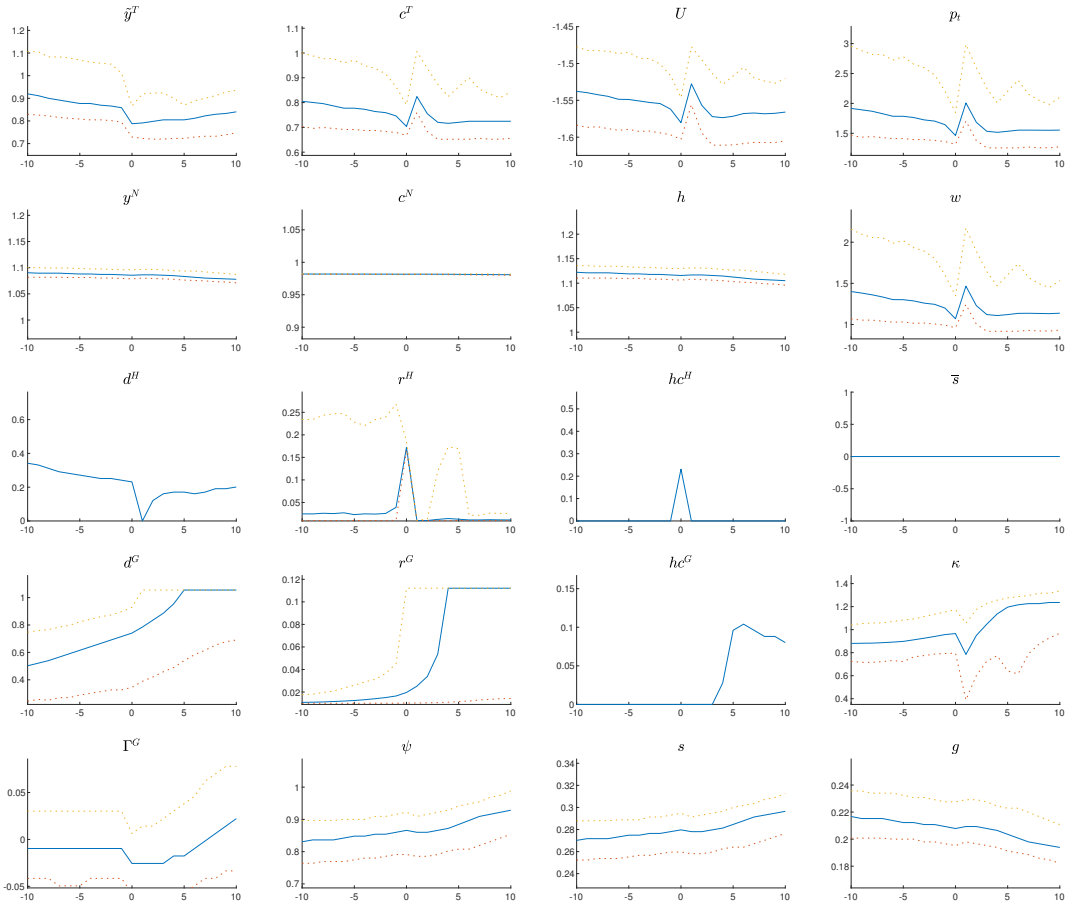


Figure 3.9: Household default sequences aligned on the default

Now to consider the more prevalent private sector initiated crises in Figure 3.9; here the household defaults on its debt. The level of household debt prior to the crisis is some 20 to 25% higher than the government default sequence. Although the private sector attempts to unwind debt, it is unable to do so quick enough to forestall the default. Immediately before default, private sector interest rates spike, $r^H$and then collapse when all the debt is written off hc^H. Although there is a period of exclusion, the model dictates that it is stochastic in duration. Therefore we observe a path where households start borrowing again expanding the economy's consumption. The ability for households to borrow includes tradable consumption that spikes inducing a spike in prices and wages in the domestic sector. As tradable income has not necessarily returned to pre-crisis norms, this recovery is weak and we observe a second consumption dip; effectively, a double dip recession due largely to a weak recovery.

Note that tradable income y^Thas a step change as sanctions bite. In the public sector, the drop in tradable income to households and impact on consumption leads to a sharp increase in the government primary deficit Γ^G,This ripples though to public debt as government is unable to respond fast enough to the crisis pushing it closer to the tipping point. With that, there is a sharp increase in the interest required by foreign investors r^G,; however, this does not always result in government needing to default. The government haircutting chart in Figure 3.8 illustrate the cases where government debt climbs too sharply (that is the upper bound in d^G resulting in the need to haircut). The effect on the domestic economy is instability in wages; however, government social transfer, although moderate, does act as a stabiliser in the domestic market. Note that, post-crisis, wages are approximately 10-15% lower than pre-crisis levels and largely flat. Although this model is founds on a long run equilibrium, it does demonstrate that a private sector crisis does bring about short to medium term changes in the economy. This would lead us to remark that, without government intervention, households suffer considerable damage as a result of a private sector crisis and much more so that that of a public sector initiated crisis.

To illustrate both the difference in paths and outcomes further we put key variable side by side in 3.10 and moved the reference point $t = 0$ left. The left column represents all event sequences; the middle column, all of the public sector initiated crises; and to the right, the private sector initiated crises. We combine wages and labour to produce labour income wh, government expenditures with social transfers gs,total income (GDP) for both tradable and domestic y and total consumption for both tradable and domestic sectors c. Clearly, the summary on the left hides the effects of private sector default. The difference in consumption between a public and private sector initiated crisis is stark with disruption to consumption, labour wage income being the most obvious. Although a public sector crisis drives up public debt to unsustainable levels, it has little effect on the private sector; whereas a private sector default causes sanctions and a rapid increase in public sector deficits, leading to potentially unsustainable levels of debt.

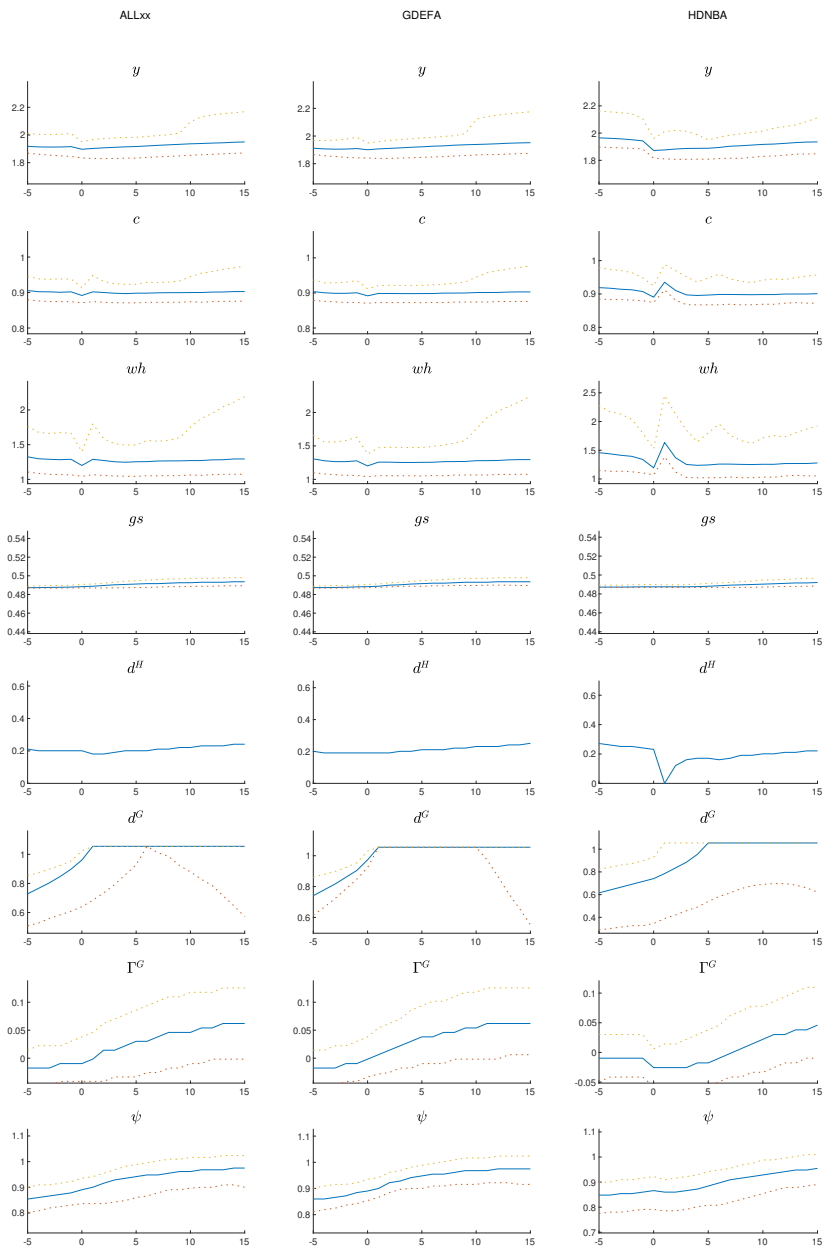


Figure 3.10: Time-paths from left to right for: ALL event classifications (ALLxx), Government defaults (**GDEFA**), and household defaults (**HDNBA**)

3.4.4 Foundation Model and the Empirical time-paths

Finally we compare the time-paths of the model against those of the empirical analysis at the end of Chapter 2. Figure 3.11 illustrates the comparison between the empirical average time-paths (left hand four columns) and that of the model (right hand). Of particular interest if medium income economies private debt dips $d^H$and government debt d^Grises. Although the entry into the crisis is different, the time-path for income y show some similarities. The summary (**ALL**, left hand column) shows reasonable alignment across income and public debt and a little less so with private debt. As the we cannot distinguish in the empirical analysis which crises resulted in a bailout by the public sector, this might confuse some of the paths. This we

will leave for later research.

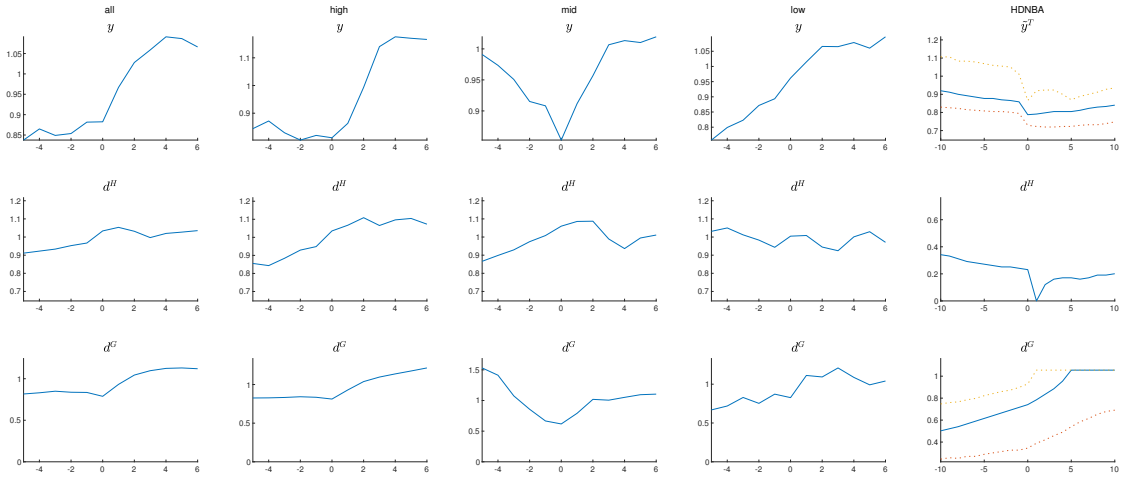


Figure 3.11: This summarises the empirical time-path results for Bank (effectively household) defaults (right hand four columns) with the foundation model's household default (**HDNBA**) on the right hand side. Left Column is all bank defaults, second left is high income countries bank defaults, third is middle income bank defaults and forth is low income economies. Note that the scaling for the empirical analysis is *different* to that of the model. The time frame: the empirical is +/-5 period either side whereas the foundation model is +/-10 periods. For a more detailed comparison, please refer to the original charts above and Chapter 2.

Next we need to consider the time-paths for sovereign default, or in the foundation model government default on public debt (**GDEFA**) as illustrated in Figure 3.12. Again, the same concerns over bailouts exist with this empirical data. The closest fit for government debt is low and middle income where the empirical analysis shows a steady rise in government debt to the crisis point and then a flattening off. This is similar to the foundation model d^G. It also shows a significant dip in private sector debt immediately after the crisis indicating deleveraging. With the model, this seems to happen before the crisis. A point to note is that in high income countries, the empirical analysis indicates a *fall* in government debt, indicating that defaulting tends to have greater haircuts that the settings for the foundation scenario and model. Likewise there is significant deleveraging in the private sector post crisis as many developed nations experienced post 2008.

There are some similarities between the empirical analysis and the foundation model, however, these are clouded with some classification issues in the empirical sources that inhibit drawing solid conclusions. Furthermore, such items as bailouts and government defaulting strategies are not recorded in the source data that supports the empirical analysis. We will see in a later scenario, a comparison between bailout of the private sector and the same empirical analysis to see if a better fit can be obtained. Certainly, middle and low income countries do have some similarities to the model in both event classifications.

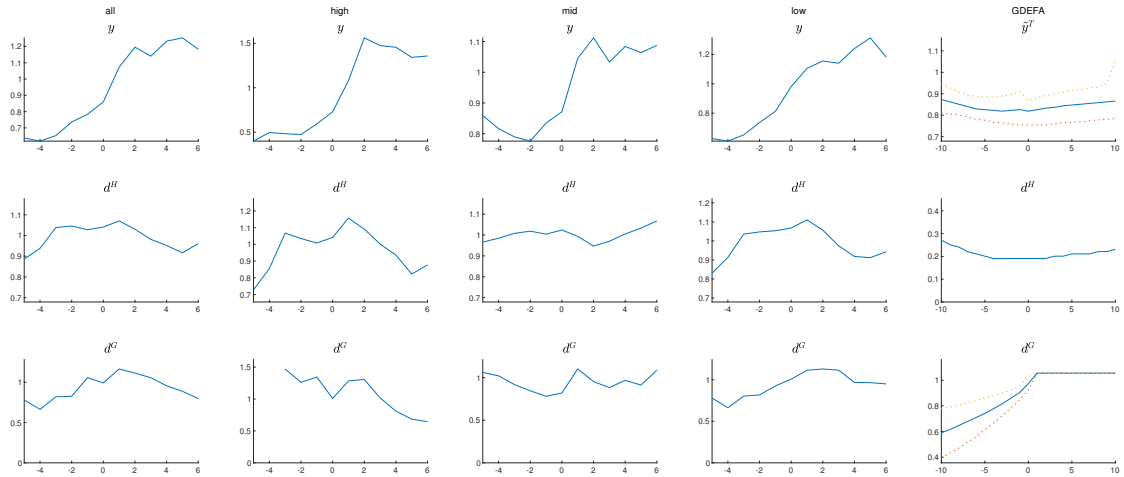


Figure 3.12: This summarises the empirical time-path results for Sovereign debt (effectively household) defaults (right hand four columns) with the foundation model's government default (**GDEFA**) on the right hand side. Left Column is all bank defaults, second left is high income countries sovereign defaults, third is middle income sovereign defaults and forth is low income economies. Note that the scaling for the empirical analysis is *different* to that of the model. The time frame: the empirical is +/-5 period either side whereas the foundation model is +/-10 periods. For a more detailed comparison, please refer to the original charts above and Chapter 2.

3.5 Conclusion

This foundation scenario is the least complicated of all of the scenarios; however, it clearly demonstrates the value of modelling private debt separate from public debt in the different path behaviour in crises with a fiscal policy rule. Similar to the data, private sector crises are much more prevalent than public sector. We can conclude that the concentration of governments and their economic advisors on public debt misses the underlying issue that is the private sector is more unstable, as we have already discussed in Chapter 1 and Chapter 2. Furthermore, even with the the inter-temporal budget constraint for the government deemed necessary be the assumption that all debt is in foreign currency, the government has a role to ensure the stability of the domestic economy though social transfers. This does bring into question the almost obsessive analysis of public debt by economists while ignoring the real cause of many crises, that being private debt.

Although this model is founded on Say's Law principles, one could easily draw that a failure in domestic consumption due to labour wage decline would itself lead to deficient effective demand for domestic goods; therefore reducing labour demand ending up in a Keynesian downward spiral. Implementing austerity measures to social transfer at a point subsequent to a crisis would only amplify the effects of the crises. We show that a weak recovery in a private sector default almost certainly induces a double dip recession that has long term implications for the domestic economy. Fundamentally, a crash in the private sector leaves significant damage in both public and private sectors with high levels of public debt, a depressed domestic sector and a low wage economy with declining labour requirements. As such parallels to the real world can be drawn with such countries as Greece in the 2008-2015 period, Argentina in the early 2000's, Brazil on multiple occasions, and many of the south east Asian countries during

the 1997 Asian Crash.

Several aspects in this foundation scenario are not covered, which leads us to move to the next level. First is that, as recent experience has told us, government do bail out the private sector. Although many would let us believe that this is a recent invention, this is not the case. Even before the Great Depression, many government have stepped in to bailout the private sector to prevent a complete economic collapse. Normally this involves a significant wealth transference from the public sector to firms and institutions in the private sector to prevent mass bankruptcy. However, in the case of Iceland, they nationalized the institutions to protect them from bankruptcy at minimal cost, then re-inflated them with their own sovereign currency though debt issuance in concert with their central bank. If, as in these models, Iceland was not able to 'create' the funds in its own currency then it would have exposed itself to exchange rate risk between its own domestic economic capacity to generate income sufficient to fund debt servicing. Sometimes governments do not bail out as they are already in a dire situation. As such, we need to consider adapting the scenario to include defaulting to lower levels of debt including a minimal level.

Second, although countries may default on part of their debt, the assumption that they are forced to the debt limit needs to be relaxed. Many countries that default foreshadow future default on up coming settlements effectively magnifying the current default event. There are many commercial and political reasons for this, partly to create leverage with foreign investors, partly to get all of the 'pain' over with in a short period politically.

Consider the arguments for expansionary vs austerity policies using the combination of taxation, social transfer and government expenditures. Even within this foundation model, government plays a significant role as a stabiliser in the domestic sector, therefore consider situations where tax, social transfer and expenditures are pro or counter cyclical with income and public debt. With this, we can change the balance between how much concentration governments give to the level of public debt, income and the level of consistency they operate by changing the fiscal policy rule parameters.

Finally, consider options on the effects of recessions on the labour market. The current flexible wage scheme means that wage rate carries all of the changes. However, a downward wage rigidity as set out in USG might create higher levels of unemployment in a recession. This concept runs counter to the Law of Effective Demand, however, may demonstrate the effect on employment, unemployment and under-employment that we so often see in many developed economies post 2008 financial crisis.

Chapter 4

Model System Design

4.1 Introduction

Underpinning the foundation model and all of the extensions is a comprehensive software suite that constructs and runs the model in a simulation using the particular scenario. The implementation of foundation model and its extensions uses the MATLAB IDE[1] to instantiate the the algorithms that realise the different scenarios in visual form. This approach provides flexibility in building a database of different scenarios over time and including them into the analysis. As we discussed in Chapter 3, the scenarios are the configuration of the calibrated parameters, strategies policy and private sector behaviour settings that the software uses to drive the mathematical model. There are four stages to creating the final output, these are:

1. The initialisation and set up. These use the input model parameters and the programme control parameters to set up all of the scenarios and the foundations for optimisation. Guidance on scenario construction is in Section 4.2.

2. Optimisation, dynamic programming state transitions, decision rules. These direct the simulation decision making that we further explain in 4.3.

3. Simulation and heuristic event analysis driven by the decision rules and state transitions is further elaborated in Table 4.2.

4. Analysis and report output. The output from these is in Chapter 3 and Chapter 5 to Chapter 8.

An overview of the software suite structure, data structures and flow charts are in 4.4. The design of the system is that all of the configuration, construction of scenarios, state transitions and decision rules are all data driven. Therefore, programmatic changes are not normally required to extend the range of possible scenarios. Any combination of the 11,500 scenarios can be run though the system without any modification. Stages 1 and 2 are only required to be run once for any set of model calibrations. Each scenario is run though the simulation and

[1] Integrated Development Environment

heuristic event (stage 3) analyser ready for the final analysis and reporting (stage 4). It is quite easy to generate new scenarios beyond the 11,500 as long as the core model model structure remains largely unchanged. Additional fiscal policy rules and realisations require only a partial rerunning of the state transitions and optimisation to facilitate a new simulation. These new scenarios can then be run through the simulation, analysis and reporting. What drives this suite is the scenarios. All of the current scenarios have their roots in the foundation scenario using it as the basis for adapting the calibration to suit the particular circumstance that the we wish to simulate and report on.

One fundamental aspect of the design philosophy is that all of the state transitions and translation tables are discrete points along the variable's continuum. The simulation uses indices rather than values and it follows coded dynamic rules as pointers rather than values. This opens up the possibility to encode any state transitions[2] having levels, discontinuity, mixed functions or similar. This gives the researcher a wide range of possibilities without fundamentally restructuring the software suite to explore different policy and strategy settings.

4.2 Scenario Construction

Fundamental to the way this software suite works is the scenario. The scenario contains a number of policy and switch settings that determine the behaviour of the decision rules and state transitions that make up the policy rules. These fit into five policy choice areas, namely:

- *Fiscal Rule* parameters that drives the core fiscal rule variable from the inputs of current fiscal rule variable value (persistence), the current income scaled by long term income, the current public debt scaled by target public debt (see Chapter 3 and Chapter 5).
- Government's response to a public debt crisis including the level of *haircutting* they will operate (see Chapter 3 and Chapter 7).
- Government policy on *bailouts* including the conditions that they use to determine a bailout (see Chapter 3 and Chapter 6).
- If the domestic labour market is *flexible or rigid wages* with the associated *flexible or fixed exchange rates* (see Chapter 3 and Chapter 8).
- The *fiscal policy realisation* that translates the fiscal policy rule into taxation, social transfers and expenditure. This can be any combination of pro or counter cyclical to the fiscal rule (see Chapter 8).

In most cases, the master list of scenarios will provide the user with the configuration that is close enough to a country or countries they wish to consider. Currently, there are over 11,500 scenarios that could be run without reconfiguration. The master list is a Cartesian product of

[2]The consumption and labour coding needs to be monotonic and increasing. Furthermore, it need to be able to be optimised. However, there are such elements as the fiscal policy rule and fiscal realisations that do not need to behave in this way.

the fiscal rule, bailout strategies, haircutting strategies, wage rigidities and fiscal policy realisation. Any scenario in the list can be run without reconfiguration of the optimization. Running a scenario involves completing a simulation followed by the analysis and reporting.

Each scenario has a unique mnemonic in the form that represents the policy and switch settings, an example is in 4.1 with the table descriptions in the following sections. We use the foundation scenario from Chapter 3 to illustrate the mnemonic encoding.

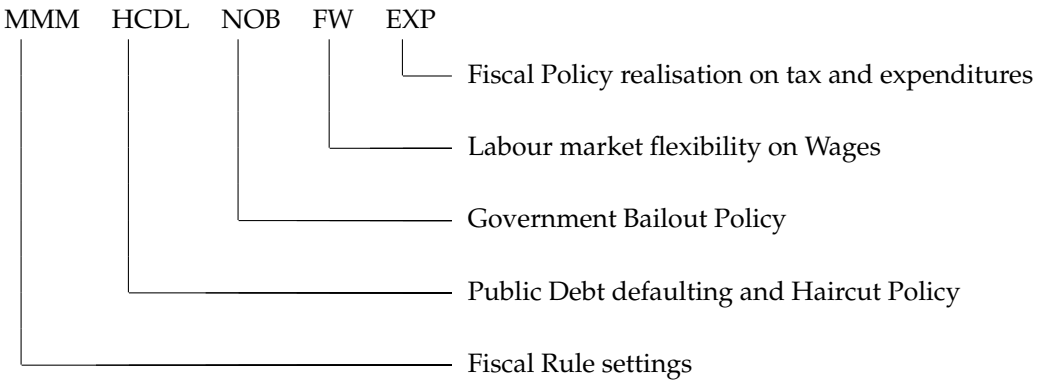


Table 4.1: Structure of Scenario Mnemonic by way of an example using the foundation scenario.

Each scenario has a unique mnemonic code that we commonly refer to throughout this work. This ensures that the the main policies and strategies are evident in the common reference across the whole system.

4.2.1 Public Debt Defaulting and Haircut Policy

We specify and illustrate the foundation scenario in Chapter 3 with the development from the theoretical foundation of the interest rate curve, debt transformation from period to period and the default by haircutting to the debt limit (HCDL) strategy. The foundation scenario's public debt strategy is one of many strategies countries in trouble employ; therefore, we need to develop new strategies that replicate typical circumstances and strategies that countries undertakes. The strategies we develop here are drawn from the publically available Paris Club agreements, IMF, World Bank and ECB literature. We have already discussed that the rather unrealistic full default where the lender receives nothing that is the foundation of many neoclassical models. The four strategies that are in the software are:

1. Haircut to the Debt Limit[3] (HCDL) - this is in the foundation scenario, however it employed in many other scenarios as a baseline strategy as it tends to extend the period of default. Although within the period, the lender gets most of their principle, continued defaulting will erode any benefit, thus a lender might be willing to negotiate a better long term outcome.

[3]With the current calibrations for the logistic function the $d^G_{NDL} = 0.93679$

2. Haircut to the Lowest Level[4] of debt (HCLL) - this replicates much of the neoclassical literature. The government does not repay anything, effectively forcing the foreign investor to write off all of the debt. This creates the shortest period of default.

3. Haircut to the primary surplus (HCPS) -This is somewhere in between HCDL and HCLL strategies. This is dynamic in that the default target level of debt derives from primary surplus affordability. This is somewhat similar to an negotiated agreement between the lender and the government and largely mitigates the risk of continuing the default that HCDL strategy and loosing much more principle.

4. Haircut to a Target Level (HC23) - This allows us to model haircutting to a specific target level[5] of debt somewhere between the debt limit and the lowest level of debt. This means we can run simulations of government defaulting and set different levels of partial default. As it follows the same logic structure that HCDL and HCLL, where there is a fixed debt level, we only test to make sure it works. It is present for completeness however, we do not use it in any of our current scenarios and would be calibrated according to the country or countries that we wish to model.

Chapter 7 extends the discussion on the theoretical basis for these strategies and employs a range of scenarios to demonstrate their effect. The implementation in the software suite is by state transition tables with decision rules that determine that path though the simulation. The diagrams in Figure 4.4 and Figure 4.5 provide a visual description of those paths.

4.2.2 Bailing Out Rules

There are four bailout decision rules that drive four bailout private debt state transition tables. If bailouts are enabled, then when the household is going to default then it refers it to the bailout tables. If the government has sufficient latitude in debt and meets other conditions of bailout , then the bailout tables determine the minimum level of bailout to prevent the household from defaulting. A full description of the process is in 4.3with diagrams to explain the paths. Therefore four bailout strategies:

1. Always bailout the household (**ALB**) - Government always bailouts out the household using primary surplus and public debt to provide the funds.

2. Never bailout the household (**NOB**) - Government never considers bailing out the household. This is the foundation scenario's bailout strategy.

3. Only permit bailout when public debt is *below* a set level (**ASB**) - if the public debt is below a level[6] the government will bailout the household. This is somewhat akin the the EU fiscal responsibility rule and its intention is as a protective mechanism for the government.

[4]Lowest level as the fiscal policy rule uses logs, therefore we use a very small public debt level 0.05 d/GDP to replicate full write off.

[5]Currently set to 2/3 between mid-point and natural debt limit

[6]Currently 60%

4. Only permit bailout when public debt is *above* a set level (**BSB**) - if the public debt is above a level the government will bailout the household. This is a 'Gamblers ruin' strategy for the government where if household defaults then government is likely to end up in default. It therefore attempts to 'out run' the debt buy bailing out the household and preventing loss of revenue in the hope that the household will not default in subsequence periods before the government recovers.

The details of these bailout rules and an analysis of their effect is in Chapter 6.

4.2.3 Wage Rigidity and Exchange Rates

We follow Schmitt-Grohé and Uribe (2016a) formulation of downward wage rigidity, where wages can inflate, however, workers will not accept significantly lower wages for the same hours. Therefore labour hours deceases rather than wages falling. We have two settings, flexible wages that we demonstrate though the foundation model and downward wage rigidity. As our model focuses mainly government policy responses rather than the household, we only partially optimise the downward wage rigidity. Our partial optimisation gives a reasonable representation of that in Schmitt-Grohé and Uribe (2016a). Noting the time that Schmitt-Grohé and Uribe (2016a) took to over a week to optimise one solution and we have 800 solutions to optimise, then a partial solution that approximates suits our policy and simulation needs. Further discussion of wage rigidities and on the exchange rate are in Chapter 8.

As to the implementation, in the original work by Schmitt-Grohé and Uribe (2016a) they did a two way contraction mapping optimisation that took over 140 hours to run. This would have given a precise optimisation map for the state transitions. As our model includes a variable rate tax, social transfers and government expenditures regime then we would take 28,000 hours without full parallel processing, clearly not achievable. Therefore, some initial testing suggested that one could come very close to their results by conducting a two pass optimisation technique. This only jointly partially optimises, however, the domestic and tradable goods markets optimise fully. The process is to first to set up tradable consumptions as a grid, then use this to form the price aspect of the optimisation in the domestic goods economy. At each point apply the down wage rigidity in a state transition model (this creates a four dimensional array) for each one of the fiscal policy realisations at each one of the fiscal policy rule states. This then sets the domestic goods consumption grid. Both of these can then be fed into the main tradable goods optimisation. where we can map every tradeable income, fiscal policy rule, wage constraint and fiscal rule realisation into the final set of state transitions. Although this process gives a partial optimisation, This process does reasonably reflect the full optimisation results of Schmitt-Grohé and Uribe (2016a) although it is a partial optimisation and suits our particular needs.

As to exchange rates, these parallel the wage rigidity. The downward wage rigidity is complemented by a fixed exchange rate as in Schmitt-Grohé and Uribe (2016a). A flexible wage has a floating exchange rate. We leave the other combinations for future model development and research.

4.2.4 Fiscal Policy Rule and Realisations

This fiscal policy that we specified in Chapter 3 has three terms to determine the one period forward setting level for the fiscal rule variable ψ_{t+1}. This would mean a 3 dimensional array to complete the state transition, one for the persistence of ψ and the two for public debt and tradeable income. This would be satisfactory if we had only one set of fiscal rule parameters. However, we have 48 sets of fiscal rule parameters which poses a significant issue for performance. The fiscal policy rule state transition arrays are but in a hierarchical indexing structure with the associated information needed for the simulations to function. As the state of the fiscal policy rule is known at the beginning of the period, we can determine the tax rates, social transfers and government expenditures by applying the fiscal rule realisations translation tables. This poses a problem for optimisation in that tax rates and social transfers pre-requisites to calculating the consumptions and labour utilities. To solve this, we create one set of optimisations state transitions per set of fiscal rule realisations. Again, this is held in a hierarchical indexing structure. Likewise, we need to consider the government budget equation with the different fiscal policy rules and realisations. We adopt a stage approach in both the data structure and simulation with feedback loop if the government defaults. The stages are:

1. Household calculates the consumptions, labour and borrowings determining if it is going to default (we treat that separately and defer discussion to Section 4.3).
2. The consumptions and labour with income come across as indices that index the government budget calculation that determines the primary surplus.
3. The primary surplus/deficit and the current public debt stock determine the demand for debt.
4. The demand for debt then translates either into the new level of debt and indicators for default and the level of haircut according to the rules.
5. if the government defaults, then sanctions are applied and the return to stage 1 (this is the feedback loop)
6. Then calculate the fiscal policy rule for the next period.

If government defaults, then sanctions will constrain the household. The household then might also default. This results in new levels of consumption and income, hence tax revenues will decline and change the government budget reduce the primary surplus (or increase the deficit). There is no circumstance where the government default would cause a rise in tax revenues as the household will suffer the same loss income.

In the above cases they do not need to be smooth functions for either the translation of the fiscal policy rule nor the fiscal rule realisations. They are all of a grid form (that is discrete points) and the simulation is reliant on indices, not values then is opens up the possibility of a wide range of policy settings and responses to events. We discuss the theory of the fiscal

policy rule in Chapter 3, its application in a wide range of scenarios that explore the limits in and application in Chapter 5, and the fiscal realisation in Chapter 8 as a set of experiments for later development.

4.3 States, Events and Event Sequences

A simulation will pass though a number of one period events effecting ether the household, government or both. Driving these events are the transitions in states for private and public debt in response to the stochastic process y^T and the stochastic elements for returning to good standing for both private and public sectors. There are two other stochastic elements that determine if either government or the private sector return to good standing after a default. In this section we describe the processes for states and events, the government decision making process, the heuristic sequence classification process, structure and construction of the software and finally an overview of the flows in the simulation process.

4.3.1 States and Events

At the end of each period the economy can be in four different states that determine the application of sanctions and exclusion in the next period. Table 4.2 specifies how public and private default affect sanctions and exclusion. If either the household or government defaults, then the imposition of sanctions on tradable income implies a loss as we have described. If one defaults, then the other could also default in the same period as sanctions are imposed immediately. If the household intends to default, then, if the policy rules on bailout permit, then bailing out the household prevents sanctions; therefore it can be in the interests of the government to bailout the household and prevent the default and change of state. The foundation model does not have a bailout condition; therefore, the household would immediately move to default and economy wide sanctions apply. The government may also default as a result of these sanctions as the reduction in tax revenue may be insufficient to generate the primary surplus to service the debt and cannot borrow to cover the shortfall.

The state transition arrays encode these consequences of state of debt and prior default into the current sanctions and exclusion status. At the beginning of each period, if the stochastic process determines either or both return to good standing. This process uses the mean sanctions periods for public and private debt and applies the function that we describe in Chapter 3 with the stochastic element to determine if either household or government can return to good standing[7]. This gives the researcher the ability to calibrate the model to the current behaviours of lenders, borrowers and the Paris Club negotiations.

The state transitions derive from single events that come about though the decision making of both the household and government. The single events are in Table 4.3 and have particular

[7]Currently Government is set to return to good standing at the beginning of every period, whereas the household averages about 6-8 periods

	Private debt	Public Debt	Sanctions	Debt excluded	Removal of sanctions
Nether in Default	Good	Good	No	None	Nil
Household in default	Default	Good	Yes	Household	Household returns to good standing
Government in default	Good	Default	Yes	Government	Govt. returns to good standing
Government and Household in default	Default	Default	Yes	Both	Both have to return to good standing, if one returns then they revert to the other's default state.

Table 4.2: Economy States

application to only some bailing out rules set out in 4.2.2. Not every scenario will result in every single event occurring. The policy settings that are interpreted into the state transition arrays determine the decisions by both the household and government. At the beginning of a period, both households and government may return to good standing if they are in default. Our initial setting determine that government returns to good standing at the beginning of the period[8].

Next to consider is the events that drive state. Table 4.3 defines the single period events that occur when either government or the household are contemplating or undertaking a default and the actions that result from those decisions. There are four bailout strategies as specified in 4.2.2. Some event types are only applicable to a particular bailout strategy. For example, the strategy No-bailout (**NOB**) will never have the event types, **BAILx** (government successfully bails out the household) and **BFHDx** (government attempts bailout but it is unsuccessful). This is important to the interpretation of the results and the event sequence classifications that derive from these event types. These event types are put into the log during the run by the simulation. Details of the logic that the simulation uses is in Figure 4.4 and Figure 4.5. These single events types allow us to use the heuristic analyser to first learn the event sequence classifications and then to classify a simulation run's event sequences. An explanation of this process is in 4.3.3.

4.3.2 Government Process in detail

To clearly illustrate the government process, the following flow chart shows the steps we model for the government in Figure 4.1. At the start of the period, the government knows the level of debt, if it was in default and if it returned to good standing. It also knows the state of the household and its effect on sanctions and finally, the budget setting using the fiscal policy instrument that was set in the last period. From this, the government can calculate the tax revenues, once it knows what the household will consume, and its expenses in social transfers and general government expenditures. As it already knows the current debt, it can work out

[8]The same stochastic process with different paths apply to both households and government. The initial settings households are excluded for about 6-7 years on average and governments that exclusion is zero.

Mnemonic	Description	ALB	NOB	ASB	BSB
BAILx	Govt Bails out Household	Yes		Yes	Yes
BFHDx	Govt Attempts and fails bailout, HH defaults	Yes		Yes	Yes
GDEFx	Government defaults	Yes	Yes	Yes	Yes
HDGTx	Government refused bailout debt greater than limit				Yes
HDLTx	Government refused bailout debt less than limit			Yes	
HD~GD	Government forced to default, because household defaulted first as government limited bailout			Yes	Yes
HDNBx	Government does not bailout		Yes		
HDNGD	Refuses bailout, Household default, government defaults			Yes	Yes
GDHDx	Government defaults, then household defaults	Yes	Yes	Yes	Yes
HDGDC	Household already in default, government default	Yes	Yes	Yes	Yes
BFGDx	Bailout Failed, government defaults	Yes		Yes	Yes
DGEXx	Government returns to good standing	Yes	Yes	Yes	Yes
DHEXx	Household returns to good standing	Yes	Yes	Yes	Yes
DGerr	Error condition, logic failure				

Table 4.3: Single event Mnemonic description and applicability to bailout rules, ALB - Always bail out, NOB - No bailout, ASB - Bailout only above limit, BSB - Bailout below limit

how much new debt to sell and once the primary surplus is evident, the policy rules that it follows, the determine the amount of debt to buy back. A short fall in the buyback is a default with a haircut. If ether household or government default, then the government will need to account for sanctions reducing taxation income and possibly creating a different outcome. At the end of the period, government knows the budget forecast fiscal policy instrument, the level of government debt and if sanctions are in place.

4.3.3 Event Sequence Classifications

Although individual events have some interest and they tend to be a part of a pattern of events that make up a crisis. However, those patterns may not be predetermined. Moreover, although there are a number of event classifications, some events are, under some policy settings, either not realistic or highly improbable. Another aspect is that we observe in the real world is that the same event may occur multiple times in a sequence and subsequently, another event occurs that terminates the sequence. Another issue is that of causality when sequencing events together that raises the question, what is the gap between events that would one normally expect that a prior event has influence on a current event?

Conservatively, one would choose a gap of zero, and the events would be serial in the time-sequence. However, the real world, does not have that tidy rule, a economy, due to its structure and inherent hysteresis may give rise to gaps between events. Consider the situation of tipping

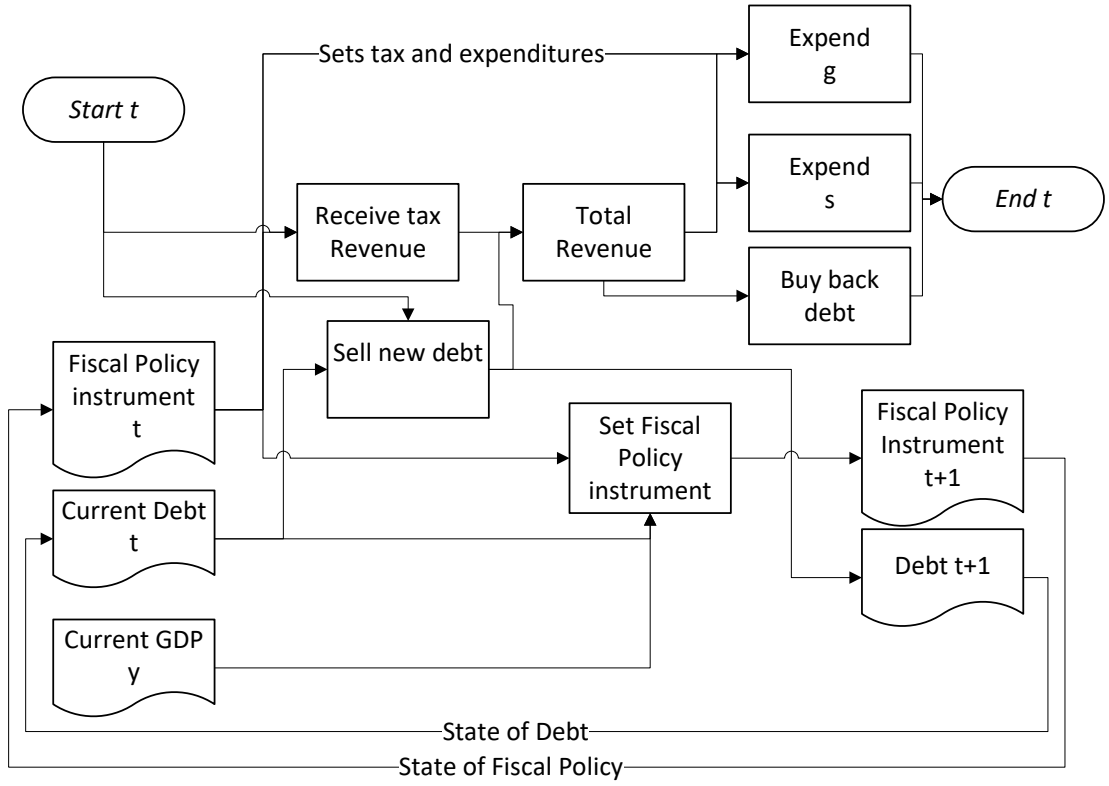


Figure 4.1: Government State Process

points where government or the household gets to a point where the almost certain outcome in a couple of periods is default. Although one may have returned to good standing, it has set off a chain of events that cause the other to fail, albeit rarely, however, it is of interest. As we discuss in Chapter 2 private sector defaults occur much more frequently than public sector especially in sovereign denominated debt and that by direct or indirect intervention.[9]

This suite uses a heuristic analysis technique to identify common patterns in the simulation results. This is somewhat akin to the way that virus detection programs work, they create a simulation environment and then look for suspicious behaviours to identify threats, whereas we looking for events that lead to and are a consequence of a crisis. The events are observed suspicious behaviours and the crisis is comes though as a sequence of events that may be disjointed. However, this may generate a number of false positives. We limit this possibility by setting the gap between to be three time-periods. Although an event sequence may involve many different events classifications repeatedly we only take the first two different events and classify the sequence as that. Although further inspection of individual events may generate insights, we are currently more interested in common patterns within a 10 period either side of the first crisis event. Because crises are relatively rare, taking a longer tail period will be reliant on less events limiting our ability to draw conclusions and the complexity of longer pathways tend to be dependent on the initial conditions leading up to the event, whereas the event itself and the immediate aftermath tends to be more compact. We demonstrate this with some of the

[9]Direct intervention is a bailout that its timing, size and nature cannot be determined prior to the event. Indirect is increasing social transfers according to a policy rule and reducing the tax burden. Bailouts are, by their very nature observable, whereas indirect may be hidden by socio-economic-political factors.

analysis in the Foundation scenario in Chapter 3.

An important aspect is to be able to compare different scenario crises, therefore the heuristic analysis builds a common database of sequences classifications that make comparisons of the affects of policy and economic constraints on the crises. We list the all sequence classification and their summarisation in The Appendix.

4.4 Software and Environment

4.4.1 Functional Structure

We utilise the MATLAB IDE as the development environment and LaTeX as the output language. We utilise mainly procedural coding with some elements of object oriented techniques to design and code the system. Much of the data is held in MATLAB structures in the form of HIDAM[10] with multi dimensional arrays for reference/static data, state transitions and HISAM[11] for output from scenarios, report generation and to the final latex output. Figure 4.3shows the data flow between core objects within the suite. The core design principles are:

- Where possible, use structured data to drive all functions. Report specification, scenario comparisons, rules etc. are all held in data and not program code.This makes adding or changing scenarios, analysis and report easier and not requiring code modification.
- The programme control parameters specifies the configuration and the way the suite will run though the process. This follows the core design principle.
- Design is procedural, block structured hierarchical utilising the dynamic call structures within MATLAB.
- All structured data is self identifying.
- Where possible, invocation of functions is from an object handler. Major elements of the reporting an analysis are object handler based functions.
- Limiting the number of parameters by passing structure dataset and that structure data sets are written in one place and read in another using common routines.

The software structure has three distinct parts, namely, set up, simulation and analysis and output. There are also a number of utilities to short cut reruns and add new scenarios and reports.An outline of the functional structure is in Figure 4.2.

[10]Hierarchical Indexed Direct Access Method
[11]Hierarchical Indexed Sequential Access Method

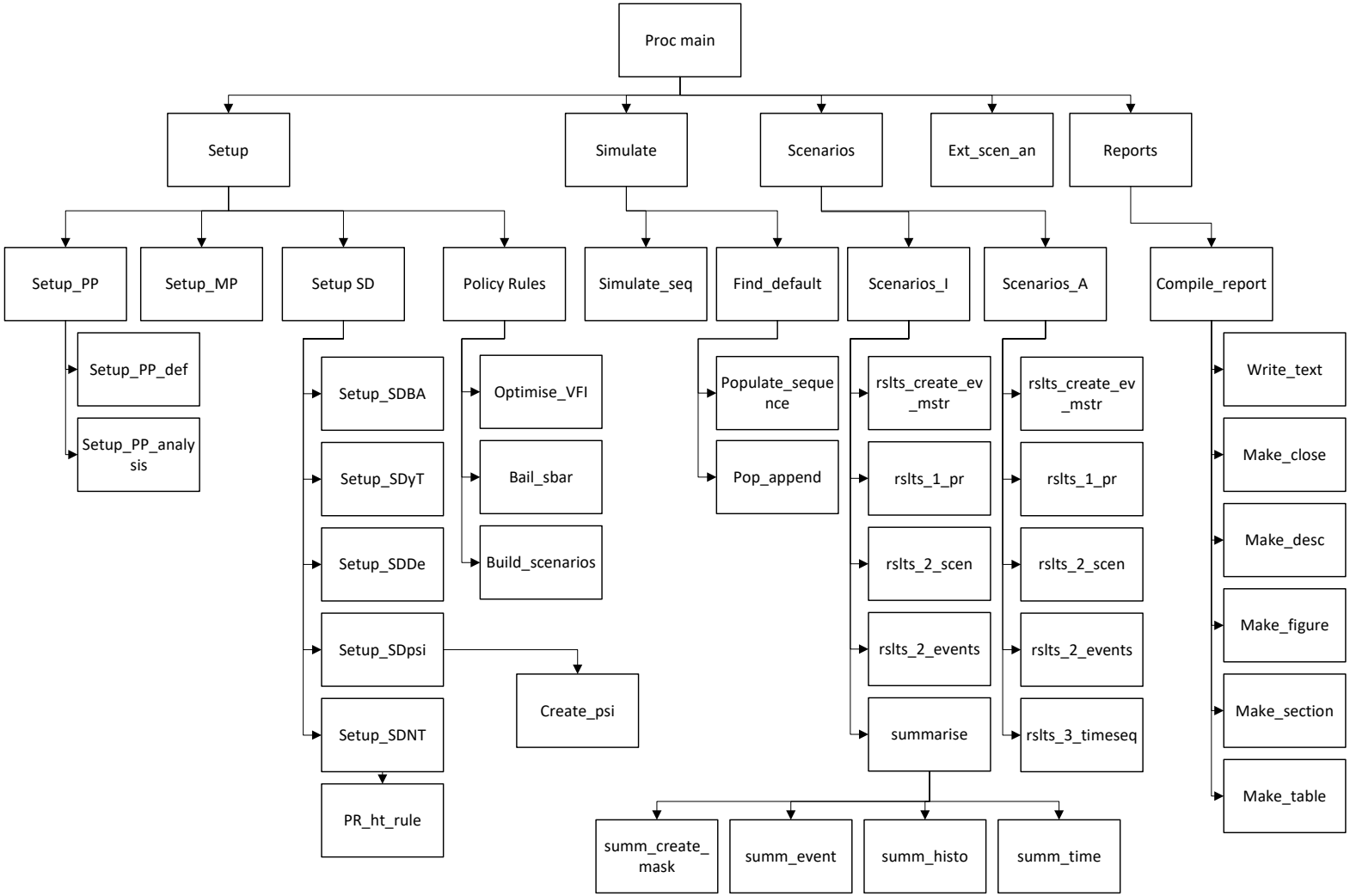


Figure 4.2: Software Suite Functional and Calling Structure. Each node represents one main function.

The Setup is made up of four components that build all of the static data and the policy rules. It also realises all of the scenario combinations and identifies the scenarios of interest based on the reporting. Setup_PP is the program parameters including all of the definitions (Setup_PP_def) such as interpreting internal variables into a form usable by latex and the analysis reports formats (Setup_PP_analysis). Setup_MP composes all of the model parameters including the ranges for the fiscal policy rule. Setup_SDBA sets up the basic and followed by Setup SD_yT the state transformation matrix for y^T and then the stochastic elements for y^T and the return to good standing sequences. Setup_SDDe puts together all of the debt matrices ready for processing. Setup_SDpsi sets the fiscal policy rule and fiscal settings state transitions components including tax and expenditures finally Setup_SDNT sets the domestic sector optimisation up including flexible and wage rigidities.

Once the static data is set up and the foundations for the policy rules then Optimise_VFI builds the household decision rules and state transitions by dynamic programming. Currently there are over 800 dynamic programming solutions necessary to run all of the scenarios. following on is Bail_sbar that builds the bailout rules and adaptations to the optimisation problem solved in Optimise_VFI. This now concludes the setup for any of the scenarios.

Next major activity is Simulate., this has two components, first is to run the Simulation sequence (Simulate_seq) that generates the index pathways so that the variables can be generated from the static data, transition matrices and policy rules. Next to populate the variables using the indexes and find all of the defaults (Find_default). This generates the first part of the Heuristic analysis by chaining events together into candidate sequences. This forms the foundation for all of the analysis and reporting.

Proc_Scenarios undertakes the detailed analysis and composition of all of the reports from the scenarios and the combination of scenarios. There are two parts, Proc_scenario_I that processes every scenario individually and creates the master event sequence table completing the heuristic analysis. This may reclassify candidate event sequences and consolidates into the ones of interest. The event sequences classifications are nor pre-determined, the derive from the data. Proc_Scenario_A builds the analysis reports that are for individual scenarios and the combination of ether scenarios or event sequence classifications for side by side comparisons. All of Proc_scenario functions generate HISAM p_code type structures for each reporting component specified in the reporting analysis table.

The final stage is Reports where all of the HISAM structures are compiled into latex ready for word processing.

4.4.2 Data Structure

The core data structures are all have a root that is a mnemonic of their role within the system. The core structure inheritance indicates the dependence structure, hence the order of processing. This will illustrate in Figure 4.3 where:

- PP - Program Control Parameters - These control the running of the suite. They include

everything from translating variable names, the report generator configuration, analysis report instructions, simulation sequences and input output specifications.

- MP - Model Parameters - These are mainly the calibrated parameters that control the calculations for the decision tables and policy rules. These are common to all of the scenarios where each scenario will pick a set of parameters according to the settings for that scenario.
- SD - Static structured Data - The suite generates a significant quantity of static data including all of the grids that translate indices from the decision tables and policy rules into values.
- PR - Policy Rules - These are the core policy rules and decision tables that drive the paths in the simulations.
- CR - Control Register - Master list of all of the possible scenarios, their parameters and configuration, the subset of scenarios that the analysis uses and recording where all of the files are.
- SR - Simulation Results - This is the indexed sequence data from simulation.
- DR - Data results from the simulation - This is the translated sequence data from SR when using the static data to translate into meaningful values.
- QR - Sequence classifications - This is the output from the heuristic analysis that identifies event sequences and dynamically classifies them.
- RR - Report structures - The core information from the analysis to generate the reports.
- DT - Data store - Common data store for report generation.
- .epsc - the images.
- .tex - latex output.

4.5 Reporting

The reporting engine in this suite is driven from configurable data structures in the Program Parameters. This takes the data and processes it into charts, tables and diagrams in latex form for use in documents. If the researcher requires a specific report, then they configure the report data structure and add in the additional report specification. One aspect of the reporting is that it generates a reporting datastore (DT) that can be reused by other programs to do further analysis and comparison. This is the way that the empirical results were compared with the simulation results in Chapter 3.

The reporting tools can generate reports for any simulation that conforms to the input standards set out in the above sections. This means a fundamental model change does not necessarily

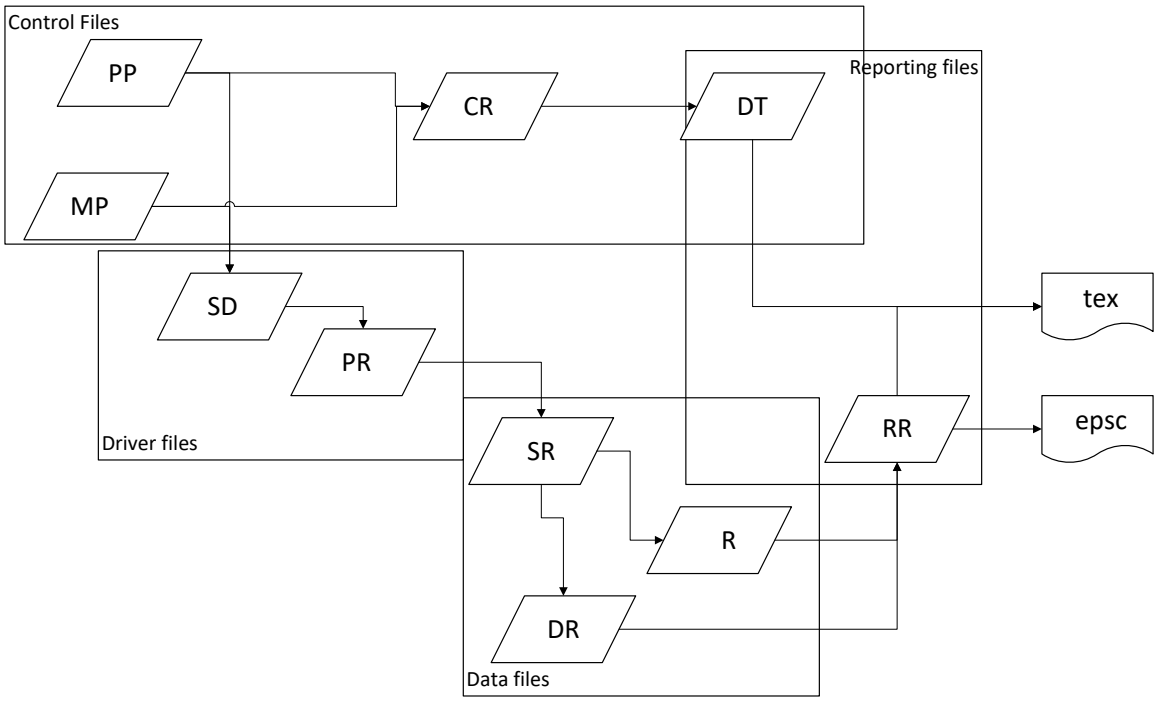


Figure 4.3: The Core Structures and the inheritance structure

mean a change to the reporting software. If additional variables are added then the configurable reporting data structures can have those added and reports automatically generated. This degree of separation allows for flexibility in the rules generation and simulation processes.

4.6 Simulation

There are three parts to the simulation, first being preparation of the common stochastic sequences, second running the simulation using the state transition and policy rules to generate indices for all of the core variables and third, populating the sequence with data from the static tables using the indices. The common stochastic sequences are for tradable income y^T sequence and its respective state transition matrix, return to good standing probabilities for government and private sector debt. The random number generator uses the same seed for repeatability. Of course all of these can be overridden by setting parameters that control the simulation behaviour without affecting decision tables and policy rules. For example, if there was a desire to test the effect of say the probability of returning to good standing, then by adjusting the threshold model parameter the simulation will automatically run with a different setting. The simulation runs with a burn in using the first 100,000 periods that is discarded. This is to ensure that stability in the process and that the initial conditions do not interfere with the analysis. Then follows a run of 3,000,000 periods that forms the analysis.

Each period runs though the logic illustrated in Figure 4.4 and Figure 4.5. As we have discussed

at the beginning of the period, government and or household may return to good standing if the stochastic process determine so. Once the new state is established, the next stage is to either process the economy in good standing (that is without sanctions) or in bad standing (with sanctions). Depending on the scenario strategy settings and the intentions of both household and government, then the process flows though making decisions from the scenario decision tables that then guide the states and stock of debt for both household and government and the flows that are associated with these stocks. The final stage is to update the fiscal policy rule to the next period and ensure that the log of events captures all of the elements. Fundamental to the design of the simulation is that is all works of decision tables and state transition arrays that the scenario parameters determine. It carries forward indices and boolean to record the state from period to period.

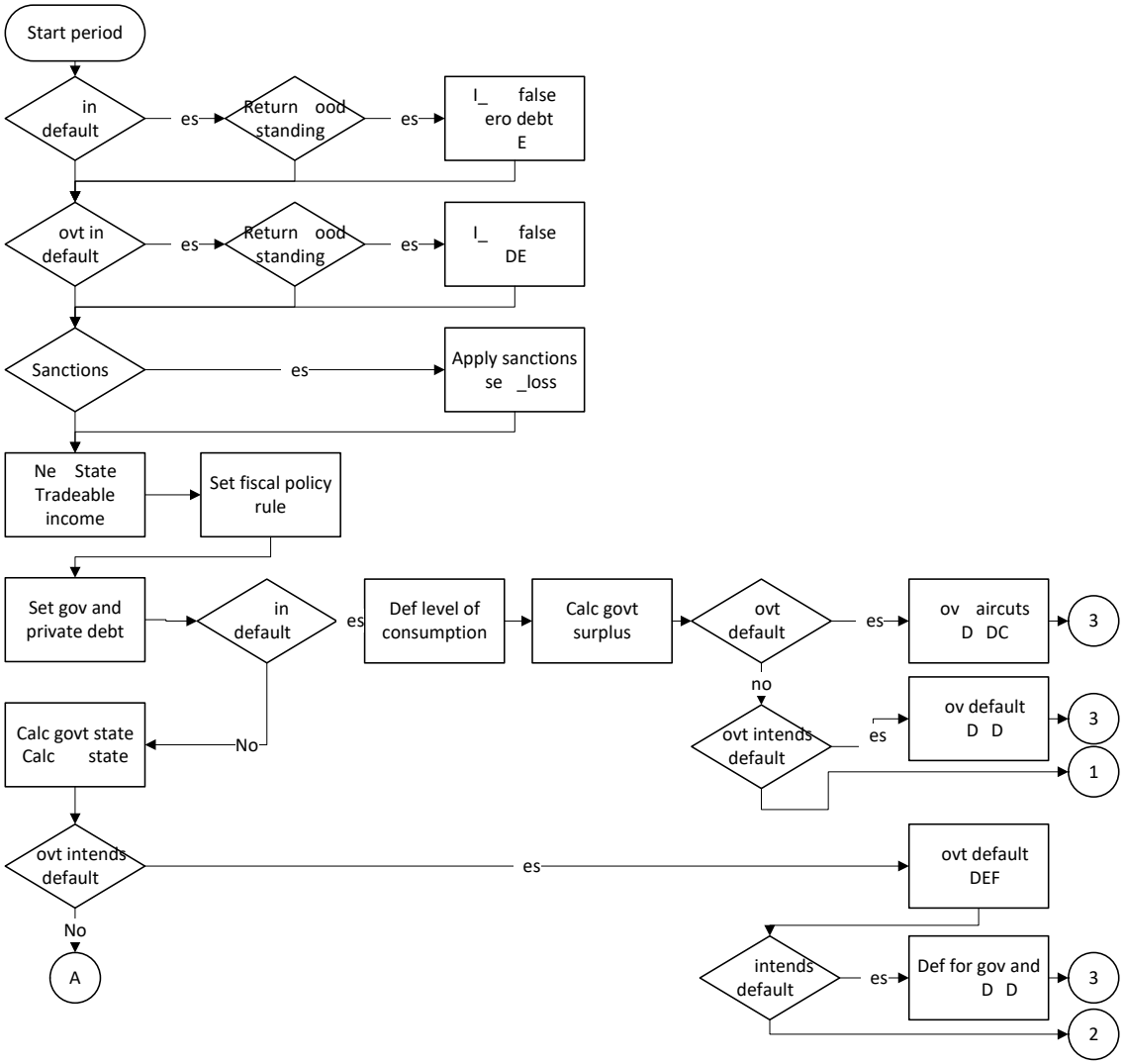


Figure 4.4: One step in the simulation process - The State Transition flowchart part 1

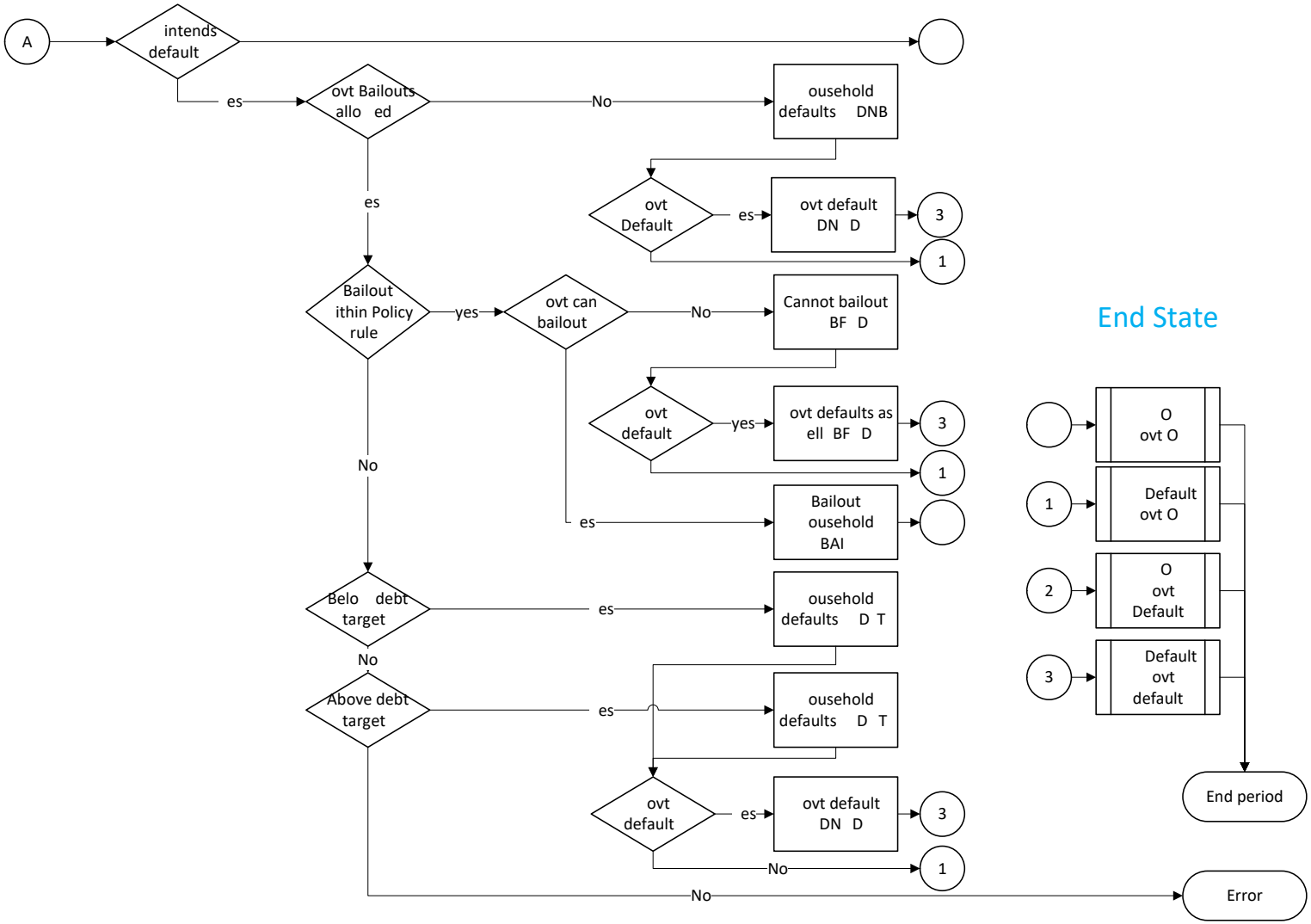


Figure 4.5: One step in the simulation process - The State Transition flowchart part 2

4.7 Conclusion

The system that supports the the foundation model and has sufficient flexibility to manage the range of strategy extensions. The design methodology incorporates state modelling using a matrix data approach that permits the incorporation extensions without the need for additional coding. Another aspect is that adding a automatic calibrator for the fiscal policy rule taking data from countries would be logical extension. By observing the interaction between taxation, income, debt, government transfers and expenses then a suitable adaptation could render a useful fiscal policy instrument. Calibration is a matter for changing Model Parameters in the model file and then re-running the set up. If a scenario is already present, however not simulated, then it is a simple task of selecting those scenarios that the researcher wishes to run and then the software will automatically generate the reports.

We have shown that the suite is flexible and the subsequent chapters we exploit that flexibility to explore the nature of policy setting through the scenarios and analyse the implications for those settings.

Chapter 5

Fiscal Policy Rule

5.1 Introduction

A core part of the foundation model is the fiscal policy rule. This mimics the role of government forward planning with a budget by setting tax rates, social transfers and government expenditures. A theoretical and model description of the fiscal policy rule is in Chapter 3, an explanation of its implement in software is in Chapter 4 and the range of fiscal policy parameters is in the Appendix. This Chapter looks to extend the use of the fiscal policy rule beyond the initial calibrations in Cantore et al. (2017). We illustrate in use by modifying the foundation scenario's fiscal policy parameters to generate new scenarios.

Our objective is to explore some of the limits of this rule within the model. What we do is use a principle in software engineering called doubling and halfing the parameters to explore the range of possibilities. An alternative approach is for us to use a selection of countries with widely different fiscal policies and apply them though estimating the fiscal policy rule. Rather than this approach, we prefer to experiment with the parameters to explore limits. If we can create a range of possible fiscal parameters then we can safely say that the implementation is reasonably generalised by testing. Moreover, when calibrating a country we could have some idea on how the model will respond to their country specific calibration and possible directions that a country could take regarding a fiscal policy style rule.

Another objective is to explore what the effects are of any giving weight to one input variable over another such as say public debt over income. This naturally leads us to the questions: should the government give more weight to long term consistency leading to some certainty for economic agents? Or should the government respond to the level of income potentially compensating for recessions and preventing booms in consumption and private debt? Alternatively, a government may have a preoccupation with public debt, Although this thought founded in neoclassical and neo-liberal ideologies, does it have substance? We explore the possible limits using the original calibration as a centre-point. Some of the limits may be unstable particularly with other parameters. We can test these various possibilities by creating new scenarios from the foundation scenario. We only change the fiscal policy rule parameters and keep all other parameters and strategies the same. Once we understand some portion of the limits of

the model, then we continue on exploring the questions of consistency of policy, is income more important than debt, is there some combination of two of them that achieves the same objective? This initial comparison provides insight into the potential directions that might be worth exploring with other parameters.

5.1.1 Setup

The we use the formulation from Cantore et al. 2017 and expand out with a range of parameter values to test the limits as we illustrate in Table 5.1. One consideration is that the fiscal policy rule in itself needs to have a long run equilibrium, hence we need to choose parameters that fit in with an equilibrium. There are three parameters, persistence, the effect of tradeable income and the effect of public debt. We want to set each parameter so that the equation is either more or less sensitive to that input variable. Within these constraints we chose a half as much again as the more sensitive for income $\rho_{\psi y}$ (High) and half for lesser sensitivity. With debt $\rho_{\psi d}$ we chose to power this by doubling the effect mainly because the starting value was quite small and then the low end half. When experimenting we found that zero did not work well with the model for the debt parameter. Finally the persistence ρ_{ψ} this proved problematic so we chose a point between unity and the foundation model for the high and 2/3 for the low. In both persistence and income we zeroed out the parameter so that we could concentrate on debt.

Parameter	Mid (M)	High (H)	Low (L)	Zero (Z)	VHigh(V)
ρ_{ψ}	$\bar{\rho_{\psi}}$	$1+\frac{(1-\bar{\rho_{\psi}})}{2}$	$\frac{2}{3}\bar{\rho}_{\psi}$	0	-
$\rho_{\psi y}$	$\bar{\rho_{\psi y}}$	$\frac{3}{2}\bar{\rho}_{\psi y}$	$\frac{1}{2}\bar{\rho}_{\psi y}$	0	-
$\rho_{\psi d}$	$\bar{\rho_{\psi d}}$	-	$\frac{1}{2}\bar{\rho}_{\psi d}$	-	$2\bar{\rho}_{\psi d}$
ρ_{ψ}	0.6252	0.7424	0.4168	0	-
$\rho_{\psi y}$	0.1478	0.2217	0.0739	0	-
$\rho_{\psi d}$	0.0777	-	0.0389	-	0.1554

Table 5.1: Fiscal Policy Rule Parameter settings. A combination these three parameters applied though the fiscal policy rule set the next period fiscal policy instrument value as a proxy for the government undertaking a budget. ρ_{ψ} is the persistence coefficient that determines how much influence the last period's policy rule setting has on this one, $\rho_{\psi y}$.

This gives a range of values that we can test that are likely to cover most countries without too much problem. We base that determination on the testing that Cantore et al. (2017) did as part of their modelling.

Next to to generate the list of possible combinations. If we take a Cartesian product of those potential parameter values the combinations would make the analysis difficult there being over 48. Instead, we focus on the mid points (using the foundation model as our benchmark) and the extremes.We list a selection of fiscal policy settings in Table 5.3. An important aspect is the

Rule	ρ_{ψ}	$\rho_{\psi y}$	$\rho_{\psi d}$	ψ_{min}	ψ_{av}	ψ_{max}
MMM	0.6252	0.1478	0.0777	0.39277	0.80341	1.3659
HHL	0.7423	0.2217	0.0388	0.37645	0.7955	1.4455
HHV	0.7423	0.2217	0.1554	0.28179	0.7911	1.5818
HZL	0.7423	0	0.0388	0.4139	0.7942	1.3147
ZHV	0	0.2217	0.1554	0.55635	0.8933	1.1159
ZZL	0	0	0.0388	0.81718	0.8968	0.9274
ZZV	0	0	0.1554	0.6117	0.8919	1.0149

Table 5.3: Policy rule parameter settings and the effect on the range and average of the fiscal policy instrument ψ

range of the fiscal policy parameter given the range of income y^T and public debt d^G.Not unexpectedly the widest range is where all of the parameter values are at their maximum (**HHV**) and the narrowest range at the smallest values (**ZZL**). The rest of the parameter settings, and strategies remain the same as the foundation scenario and any difference in the results from simulation are solely due to the parameter changes. This provides a reasonable benchmarking approach using the foundation as the benchmark and then the alternatives challengers.

Rule	τ^c_{min}	τ^c_{av}	τ^c_{max}	τ^y_{min}	τ^y_{av}	τ^y_{max}	g^T_{min}	g^T_{av}	g^T_{max}	g^N_{min}	g^N_{av}	g^N_{max}	s^T_{min}	s^T_{av}	s^T_{max}
MMM	0.019	0.040	0.068	0.094	0.192	0.326	0.228	0.112	0.066	0.228	0.112	0.066	0.253	0.124	0.073
HHL	0.018	0.039	0.072	0.090	0.191	0.345	0.239	0.112	0.062	0.239	0.112	0.062	0.266	0.125	0.069
HHV	0.018	0.039	0.072	0.086	0.189	0.345	0.250	0.113	0.062	0.25	0.113	0.062	0.277	0.126	0.069
HZL	0.020	0.039	0.065	0.099	0.191	0.315	0.217	0.112	0.068	0.217	0.112	0.068	0.241	0.125	0.076
ZHV	0.027	0.044	0.055	0.133	0.213	0.267	0.162	0.101	0.080	0.162	0.101	0.080	0.180	0.112	0.089
ZZL	0.040	0.044	0.046	0.196	0.215	0.222	0.109	0.100	0.096	0.109	0.100	0.096	0.122	0.111	0.107
ZZV	0.030	0.044	0.050	0.146	0.213	0.243	0.147	0.101	0.088	0.147	0.101	0.088	0.163	0.112	0.098

Table 5.4: Policy rule settings effect on fiscal policy parameters with an **EXP** (expansionary) fiscal realisation. Note that where the minimum is greater than the maximum, the variable is downward sloping

All of the tax rates, government expenditures and tradeable social transfers remain the same as the foundation scenario. If we apply the policy rule range and the averages to the expansionary fiscal realisation (**EXP**) then we get the range and average for taxation, social transfers and government expenditures as we illustrate in Table 5.4.

5.1.2 Policy Rule Descriptions

Some interesting aspects here are that some of the fiscal rule settings widen the range and shift the range up or down the scale. This alters the government's dynamic with the household that changes the consumption and debt levels of both, this, in turn, changes the domestic market for labour and consumption. We give the following interpretation to the fiscal policies:

1. **MMM** Foundation - this is a moderate path that takes into account the need for consistency of policy and gradual change whilst responding income changes as well as debt.

There is bias toward consistency in the Foundation with more emphasis on income than public debt.

2. **HHL** This strengthens the bias in **MMM** with a strong focus on consistency and income driving the budgetary process and debt being of little concern. Therefore the government is likely to increase net contributions to the household in a downturn. This itself may prevent the household from defaulting. This creates the most expansionary policy in a downturn following more Keynesian expansion that one would expect of a sovereign debt country.

3. **HHV** This is effectively a multiplier to the **MMM** policy, however there is a stronger focus on public debt whilst maintaining consistency and that procyclical on income for household transfers.

4. **HZL** The focus is on consistency and no consideration of income and little for debt. Therefore government values consistency over that of net contributions to households. One could classify this as conservative in policy that consistency matters

5. **ZHV** Government only response to income and debt and does not consider consistency. This means that government budgeting can fluctuate significantly with potentially opposite forces of income and public debt.

6. **ZZL** Fiscal policy effectively flat lines except for a little variation to public debt. The influence of this would be small. This follows more the Austrian ideology of non-interventionist policies by government and let the market decide.

7. **ZZV** Focus is all on public debt regardless of consistency and income. This makes the Expansionary Ideology into an Austerity policy about 'getting the debt down' in that when debt is high, then fiscal instrument is high, taxation is high with low social transfers and government expenditures. This is almost the opposite policy to that of HHL.

The diametrically opposed fiscal rule policies would be **HHL** is diametrically opposed to **ZZV** the former being expansionary in a recession and the latter being contractionary in high debt situations, normally as a result of a recession. Another opposite is that **HZL** and **ZHV** where the former focuses on consistent policy even in light of recessions and high debt levels whereas the latter reacts quickly to recessions and high debt. **ZHV** might generate instability with the expansionary fiscal ideology and might generate a double dip recession though the mechanism of a recession starting with low debt, then social transfers increase, creating a public deficit increasing debt that would then increase taxes and reduce social transfers.

One item to note is that the **EXP** policy only is expansionary if the fiscal rule focuses more on income that public debt, namely **HHL**. From the table, we demonstrate that though the Fiscal ideology, a configuration between ideology and the fiscal rule can create a 'deficit hawks' and 'debt hawks' by focusing on public debt as the core of fiscal policy. In the last 40 years, we can observe a significant shift in developed nations ideology and that ideology being imposed on developing nations that high levels of public debt are 'bad'. A clearer observation is with the

fiscal policies post 2010 for the UK and the imposition of such policies on Greece, Spain, Ireland and Italy. Further examples are where the IMF imposed conditions on Argentina, Brazil and many African countries. This fiscally conservative policy that sees public debt level as a proxy for a poorly run government.

A question here is does this benefit the country with stability, prosperity and the resilience to respond to external crises? Alternatively, it may stabilise the debt, however does it do this at the expense of the household? One aspect to consider that we saw in the foundation scenario, namely, that and externally induced recession will turn any primary surplus into a deficit, that deficit will increase debt and with this most conservative of policies, does that induce increasing taxation on the household and reducing social transfers in the middle of a recession or weak recovery. This somewhat follows 2010-2015 UK government's policy where there were significant reductions in social transfers (that is cuts to social services) and reduction in taxation for higher income groups, however, little in reductions to lower income groups and with the effects of higher consumption taxes that disproportionately affect lower income groups, we can conclude that the average or 'representative' household would have received a reduction in net transfers. Therefore we might observe a so called 'double dip' recession. We would be looking for that in a situation where households 'default' on their debt.

This leaves us with some important questions. first, do the extremes cause instability and if so, under what circumstance. Does a focus on debt lead to a double dip recession.Can the government use social transfers to bolster the household in a recession. How does consistency affect the response by government, noting the forward planning model inbuilt into this analysis that naturally creates a lag between the event and the response. Consistency would create the effect of a greater lag in fiscal policy realisation though taxation and social transfers. An important aspect is what is the effect on the domestic economy of such policies? Our focus is crises and its aftermath rather than the periods in between, therefore use the crisis events of private and public debt default.

5.2 Simulation Results

First we will look at the pathways for each one of the scenarios and comment on the responses to different crises event sequences. We assume that the discussion in the foundation model provides the sufficient background and we do not repeat that here. We compare the number of events that occur in the simulation for each scenario in Table 5.5 with the summaries in bold. For easy comparison a bar-chart by Scenario provides a visual comparison of the table in Figure 5.1. The left hand column is the foundation scenario and it immediately becomes evident that increasing the weighting generally increase the frequency of all events (**ALLxx**). Further inspection of summaries **GDEFA** (government default) and **HDNBA** (household default) indicate that fiscal rule calibration has a significant impact on the frequency of government default with minor impact on the private sector. We can draw out that government fiscal budgeting preferences of consistency, income and debt have a significant bearing on government debt stability. One question was about the effect of an expansionary policy that takes

account of income and consistency whilst paying little attention to government debt. Part of this was that in a recession, the net transfer to the household is elevated and likely to prevent a household from getting near to default. Our simulation in **HHL** indicates that this type of policy reduces household default by 25% whilst doubling the possibility of government default. Although this is the least stable in terms of the frequency of events, such instability does not induce the household to default at a later stage (**GDEFx.GDHDx**) unlike that of where very active involvement (**HHV**) does induce a greater sequence leading to a household default.

Scenario	MMM	HHV	HHL	HZL	ZHV	ZZV	ZZL
ALLxx	**27734**	**37175**	**30488**	**24335**	**25398**	**24484**	**23753**
GDEFA	**6638**	**15005**	**14609**	**883**	**2983**	**343**	**264**
GDEFx	6104	10619	12922	780	2754	306	230
GDEFx.GDHDx	125	3766	975	16	37	4	10
GDEFx.HDNBx	409	620	712	87	192	33	24
HDNBA	**21096**	**22170**	**15879**	**23452**	**22415**	**24141**	**23489**
HDNBx	19882	18350	13548	23378	21906	24108	23468
HDNBx.GDEFx	1115	3441	2110	66	469	27	20
HDNBx.HD˜+GD	99	379	221	8	40	6	1

Table 5.5: Summary of the frequency of Event Sequences. Summaries are in bold.

Except for **HHL**, the rest of the scenarios induce a small, nevertheless, significant increase in household default over the foundation scenario. in the range of 5% to 10%. The scenarios where either consistency and/or income is not a factor (**HZL**, **ZHV**, **ZZV**, **ZZL**) then government tends not to default as frequently. It seems that the combination of consistency and income focus leads to increasing possibility of government default. The most austere scenario **ZZV**, behaves as one would expect in that the government is protecting public debt when it potentially becomes unsustainable. This has some consequence on the household with the highest frequency of default for all the scenarios we consider here. Government defaults are so infrequent as not to occur as is with **ZZL** and **HZL** with only slight elevation in household default rates. This seems to imply firstly that the more note government takes of income the more likely it is to default and secondly, if government does take account of income and consistency then to reduce the effect on the household it need not take account of public debt (comparing **HHL** with **HHV**). We suspect that the net transfers to the household to make up for shortfall in income is having an effect here on both the household and government, effectively transferring the risk from household to government.

A point to consider is does the household defaulting cause the government to default? that is sequence **HDNBx.GDEFx**. Policy **HHV** tends to create the greatest possibility that household default causing a government default. This could be likened to a government that is trying to adopt a policy that is highly consistent whilst being highly aware of income and debt issues. It almost indicates that if the government focuses on too many factors at the same time giving particularly high weight to all of them, is likely to create greater instability causing both household and government both jointly and separately to default more frequently.

Next is to consider the length of defaults, costs of default and their time paths under each one

of the scenarios, again, using the foundation as a benchmark. We finalise by undertaking a cross scenario comparison and the draw conclusions on the fiscal rule policies.

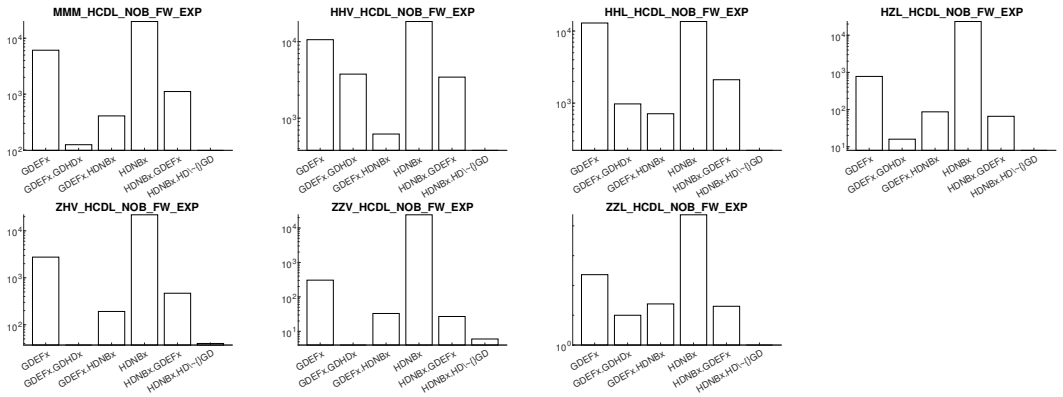
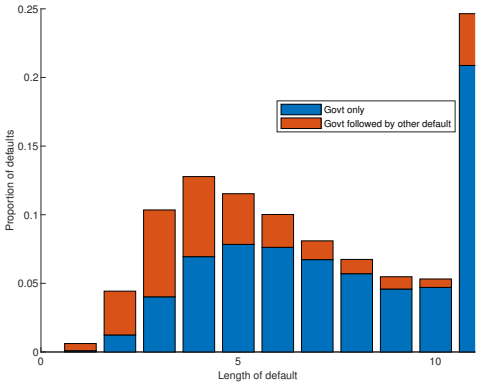


Figure 5.1: Histogram of the frequency of each event sequence

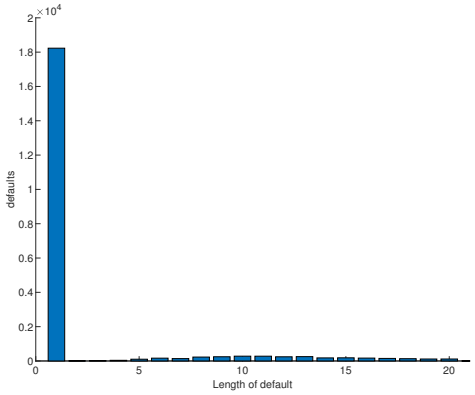
5.2.1 HHV - Expansionary Policy in a Recession, However Moderated by Debt

This scenario intends to mimic a government that seeks to be highly consistent in its fiscal policy whilst being very attentive to both national tradable income and debt. Note that this policy configuration generates the highest number of crisis sequences of any of the scenarios we consider in this comparison and that about 1/4 of the Government defaults (**GDEFx**) lead to a household default (**GDHDx**). The nature of **HCDL**, default - haircut to debt limit is that this tends to generate long government default sequences only recovering when there is sufficient primary surplus to cover the service charge and lower the principle to more sustainable levels (Figure 5.2b). Note that shorter duration of government defaults sequences tend to lead to household and government defaults together (**GDEFx.HDGDx**) with only limited circumstances where government recovers, however household has not (**GDEFx.HDNBx).** This in in contrast the private debt where most of the defaults are of one event (**HDNBx**) followed by a period of exclusion that prevents them from defaulting again. However, there are some cases where the household defaults multiple times within a sequence. In both cases, that period where government and or household is defaulting results in cost to the foreign investor in haircuts.

We observe in Figure 5.3a that the foreign investor haircut tends to be more frequently small, that is skewed to the left with a long tail shown by the large vertical bar on the right regardless of if it is the household or government. A question here is that is small cost due to deleveraging prior to default by households or likewise by the government or is it some other dynamic? We discuss this later in the time paths. There are a small, however, significant number of sequences that result in significant loss to the foreign investor, this is important as an investor will normally get 'hit' with a smallish haircut, however, very occasionally, a sequence leads to a significant loss. These big losses come from public debt default rather than the private Figure 5.3b.

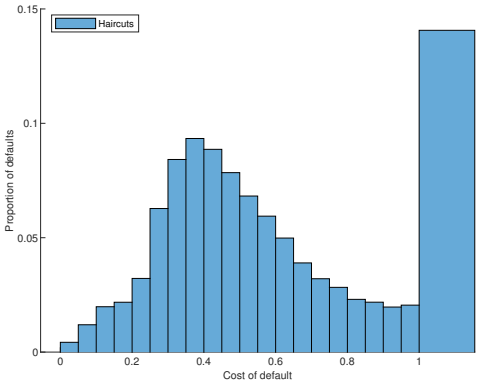


(a) HHV - Distribution of duration in default by the Government. Blue is government only, brown is the additional defaults in the private sector that occur as a result of government

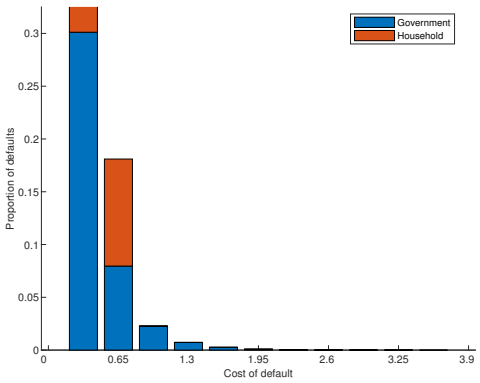


(b) HHV - Distribution of the duration in default for the private sector

Figure 5.2: **HHV** - Distribution of the durations in default



(a) HHV - Distribution losses from all defaults



(b) HHV - Distribution losses from Government and Household defaults to foreign sector (note that the first column is trimmed to give visibility to the cost dynamics.

Figure 5.3: **HHV** - Distribution of losses from defaults

It is likely that a government may end up in a 'death spiral' with foreign investors until some stability in primary surplus occurs. Both investor and government are locked into this cycle. We discuss these dynamics further in this chapter for haircut models Chapter 7. An interesting comparison is between the various fiscal policy rule settings on how long the government remains in this 'death spiral'. One would anticipate that if government focuses more on debt than income then with the Expansionary ideology, this will generate surpluses when debt is high regardless of income. This is something we discus in **ZZV**.

5.2.1.1 Time Paths for Crises

A government that tries to be consistent and responsive my give ambiguous signals and may induce undesirable responses by other actors. First lets consider the time path for variables when centring on a household default crisis. In Figure 5.4 we observe the slow decline in tradable income $\tilde{y}^T$ until it reaches the point $t = 0$ where crisis is centred, Household default at this point, the first crisis event **HDNBx**. This creates an immediate loss to the economy as we have already described in Chapter 3. Even though the household was deleveraging prior default d^H and reducing consumption in the tradables c^T it was insufficient for it to continue and its willingness to repay subsided and the household defaulted and the debt was written off. This loss in income and consumption, creates a primary deficit for the government Γ^G leading to a rapid increase in debt. One aspect of this is that government Fiscal Rule instrument would be sensitive to the declining income, thus lowering taxes and increasing social transfers, however the debt effect does not come in until a couple of periods of accumulated primary deficits. The rising debt becomes the focus that drives the fiscal rule instrument driving up taxation and reducing social transfers.

A point to note is the s in these charts is both tradable and domestic social transfers, in this case g follows the same time path as s^T and that indicates that government's social transfers switch from tradable sector to domestic sector keeping domestic consumption c^N reasonably flat even with a real wage depreciation. The up-tick in c^T immediately after the default event is the return of the household to good standing and a one period, bonus of not needing to service debt. however, this short lived and consumption reverts to a level that is deeper than the crisis event with a long tail even though tradable income $\tilde{y}^T$ is increasing during the period This effectively creates a double dip recession with a long tail with parallels to that experienced in the UK. The fall in price reflects though to real wages and although government, though social transfers is able to maintain consumption, it is unable to maintain employment with a gradual decline in labour in association with real wages. This is seems to reflect the experience of many worker in developed economies post 2007/8 financial crisis, that is immediately unemployment and then under-employment.[1] This under employment and low wages leads to deficient effective demand in the Post-Keynesian world. That in turn leads to under-investment in labour and capital. The lower investment in labour (wages, employment and under-employment) keeps the economy trapped in a low productivity environment and we show that even with direct social transfers, the economy is, at best, slow to recover.

This low ebb in the economy has a direct effect on the government, it needs to increase revenues to stave off the climbing public debt. Its initial response may have been expansionary in tradables, however debt becomes the focus driving the fiscal policy instrument up, taxation up with falling social transfers and government expenditures in an attempt to create a surplus. In some cases, the government ends up haircutting its debt as the interest rates climb exponentially. The experience of the household reflects into the government becoming trapped into trying to

[1] Under-employment is where skilled workers are employed in work that requires less skill therefore, the productive value add is potentially attenuated. An economy may have full employment with under-employment. This has a direct impact on output as the effective supply, if allocations fully employ all of the skills, hence maximise the output, then effective supply would consume all of the productive capacity of the labour force.

create surpluses to keep debt under control at the expense of the household. Effectively, with debt denominated in a foreign currency, both household and government become trapped in a long term depressed economy waiting for tradable income to recover (exogenously).

Effectively, the initial focus on income limited the effects of the crisis however, public debt ends up ruling policy keeping the economy trapped. The domestic economy fairs no better with low wages, under-employment and depressed output. Even in 15 periods, the economy remains in this low state.

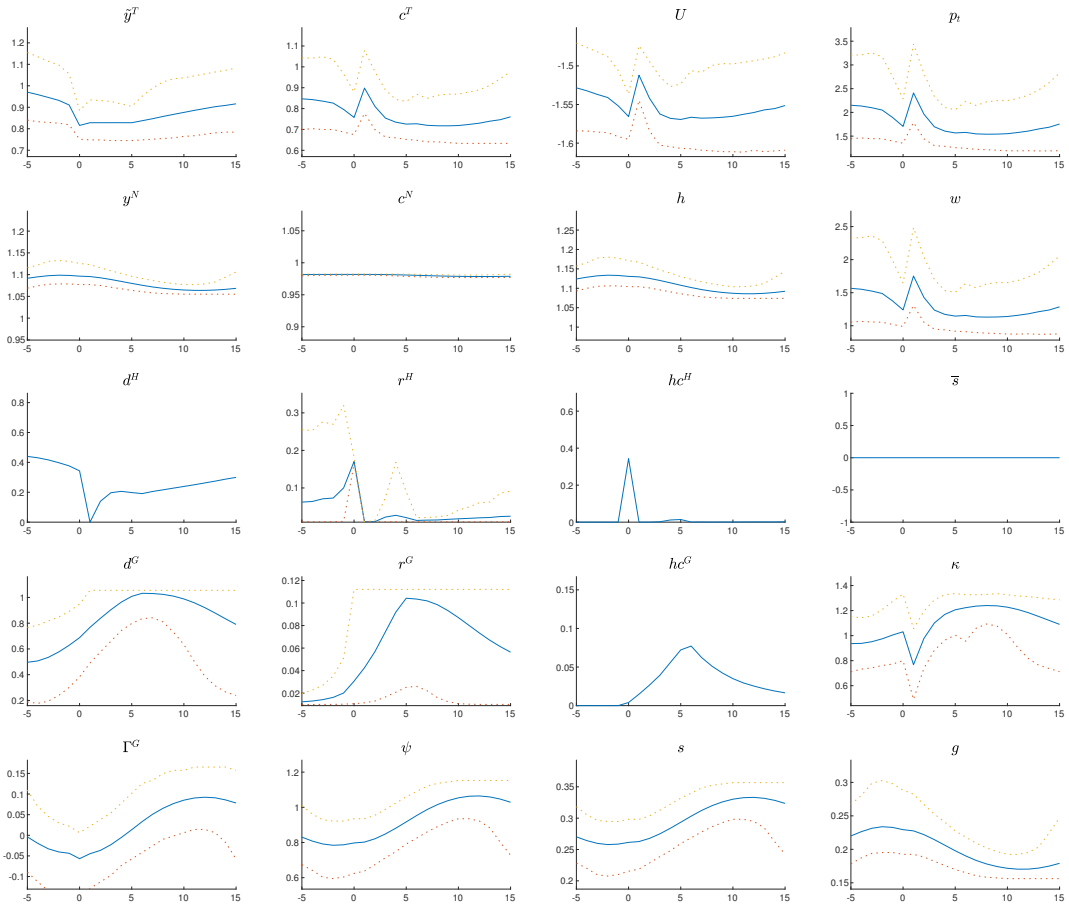


Figure 5.4: **HHV** - Household initiated default time paths

The less frequent crisis derives from a government default event (**GDEFx**). The fiscal policy rule does not directly drive the response to a default event, that is the role of default and haircut policy, it indirectly influences the path. A not unexpected core characteristic is that the government runs a primary deficit leading up to the crisis (Γ^G). At the same time the declining tradable income decreases both the tax rate and tax revenue whilst increasing social transfers and government expenditures. Government debt explodes as interest rate climb leading to the default event. At the time of default, Sanctions have an immediate effect on tradable income $\tilde{y}^T$with a sharp dip. This has a knock on effect to debt and consumption. Note that in the domestic market, output was declining prior to default, however consumption was flat and domestic social transfers make up the shortfall.

Post crisis, the domestic economy experiences a fall in employment with a fall in real wages

following the curve of p^T. However, the effect is nowhere near as dramatic as that of a private sector default. Likewise with the double dip, it is small and only for a very short time. Government debt remaining at its peak determines the involvement of government in the private sector, the normal path is that it remains at the peak for 3-5 periods then a slow decline. This reflects the haircutting and interest rates and follows though to the fiscal rule gradually declining. AT the end of fifteen periods, the economy is in recovery, not quite pre-crisis levels, however the stagnation when private debt defaults is not apparent here. There is a dip in employment and wages with a dip in domestic output, however, it is both short and small when comparing to private debt crisis.

This fiscal rule setting tends to exacerbate the effects on the private sector whilst moderating the effects on the public sector. This is a question for the comparison across scenarios.

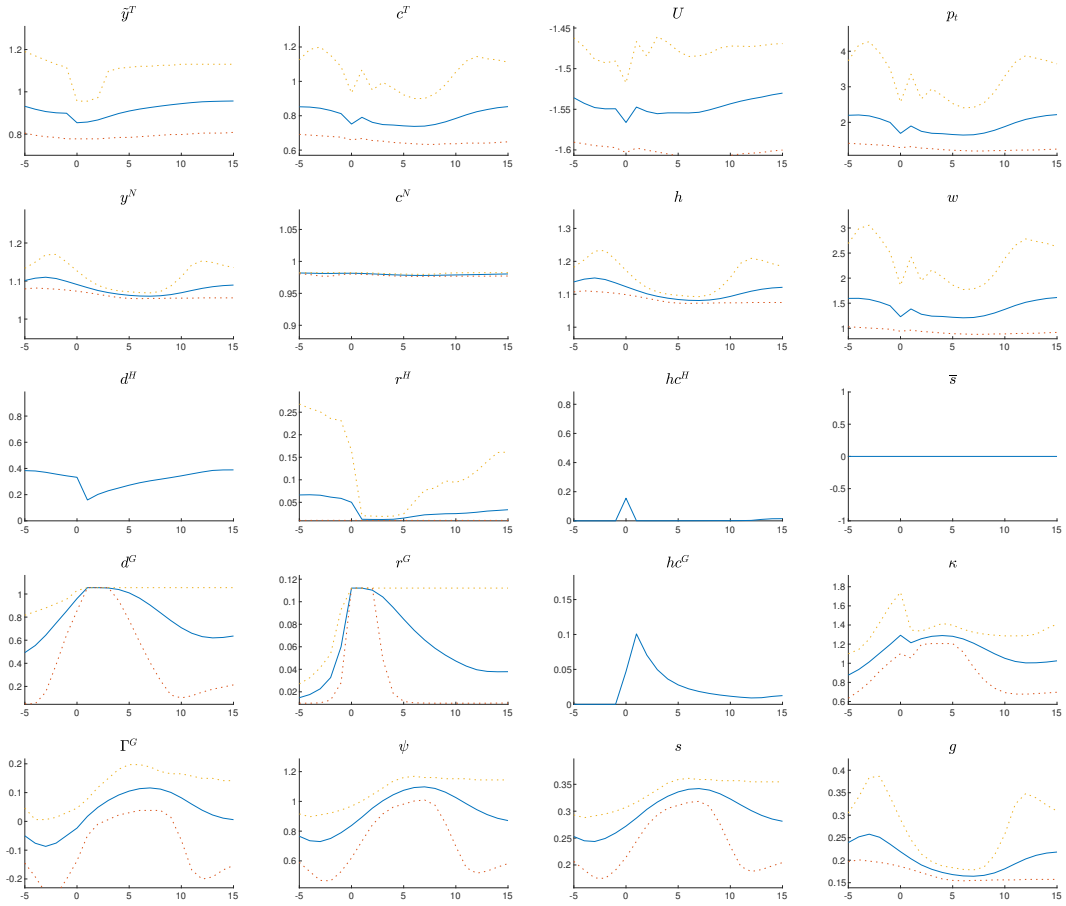
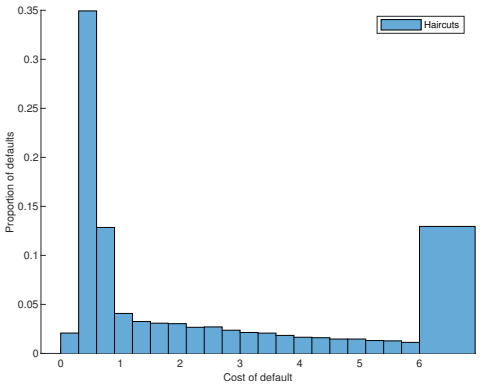


Figure 5.5: **HHV** - Government initiated default time-path sequences

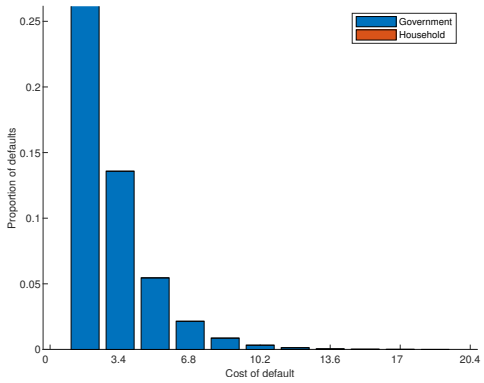
5.2.2 HHL - Expansionary Policy in a Recession and Not Considering Debt

In this scenario, government's strategy is around consistency and income that will, with an expansionary ideology, making up for shortfalls in household tradable income and possibly reduce the incidence of default. Our summary above, indicates that is the case, however, these is a trade-off with greater incidence of public debt default crises. One aspect to policy setting is does it perform better than **MMM** whilst not having the downsides on the private sector. One

aspect is the distribution of costs on default as we show in Figure 5.6 when we compare with those of **HHV** that takes public debt into account. Most defaults tend to be of low cost with a long tail of infrequent defaults that create large losses for the foreign investor (Figure 5.6a). The cost of household default is very small in this case indicating that the government is carrying most of the cost of defaulting. Because government takes very little account of public debt then one would expect it to default more than if it took the opposite view (**HHV**). This is not the case in this model. A government that aggressively attacks debt tends require the private sector to pay substantially more tax, hence putting the private sector at risk. Effectively the government passes the risk of default from the public debt to private debt.



(a) HHL - Distribution losses from all defaults



(b) HHL - Distribution losses by investors from Government and Household defaults

Figure 5.6: **HHL** - Losses by investors from default

There are to main sequence classifications for this **HHL** policy with an expansionary ideology that we consider, namely, the summary classification: **HDNBA** - Household default, no bailout and **GDEFA** - Government default. We illustrate their time paths in Figure 5.7 and Figure 5.8 respectively.

With a private debt crisis, that is sequences starting with **HDNBA** in Figure 5.7, we observe that a default event sequence has similarities to **HHV**. In the tradable side of the economy, we observe that consumption after the crisis and spike, flatten at a slightly lower lower level even though tradable income is increasing. Government is not aggressive on taxation as ψ only gradually increases in line with tradable income. One aspect is social transfers, their is a less of a curve upwards and as tradable social transfers follow the government curve. Social transfers with lower taxes flattens the tradable consumption limiting the effects on the household. In the domestic sector, social transfers are significantly less, however taxation is also significantly less. Wages post crisis, are flat with no sign of recovery, largely driven by the marked price change. There is also a slight decrease in labour output and labour hours, however not to the same scale as **HHV**.

Not unsurprisingly, the effects are more in the government side where debt increases to potentially unsustainable levels. It does not respond with increasing primary surplus, remaining

in deficit Γ^G for much longer than **HHV** In some cases this results in the government haircutting hc^G. Because government does not respond though the fiscal policy rule ψ to debt d^G, debt remains high and persistent leading to much greater losses to the foreign investor hc^G. If the government defaults as a result of a household default then government remains in this long term debt crisis until tradable income recovers sufficiently that it can start repaying its debt. This is a function of ignoring the role of public debt that is in a foreign currency in fiscal planning and only haircutting to the debt limit (**HCDL**). In turn this drive the loss function on tradable income that effectively traps both private public sectors into a long period of stagnation. AN important point to note is that private debt recovers quickly, however, not to the same levels are pre-crisis within our window.

Although on the face of it, this expansionary policy that addresses the initial crisis most likely better than the **HHV** policy, it seems to trap the economy in a low state largely from the high levels of government debt. There is a trade-off here between exacerbating the pain during the crisis and having a long slow recovery, or lessening the effects of the crisis and possibly lengthening the period of stagnation. If the government can avoid defaulting, then the recovery would be much quicker and from a post crisis level that is better than **HHV**. This is possibly where the role of negotiation with foreign investors may lessen the debt service costs, therefore reducing the compounding effect giving more room for the government to use debt to attempt to resolve the problem in the tradable sector. Further investigation to the different time paths of **HDNBx** - that is household defaulting sequences only and **HDNBx.GDEFx** - this is household and then government defaulting sequences would further highlight these differences.

Moving now to government default sequences, that is **GDEFx** is the initiating event, we show the time paths for the core variables in Figure 5.8. The first item is that the tradable consumption is flat, except for a short period event at the time of the crisis. Tradable consumption does not have the pronounced dip that **HHV** has and this reflects though the prince . However, in the domestic sector there is a slow, gradual decline in output and employment, with wages never really recovering. During this period the government has a persistent debt crisis that seems to repeat at every period, eventually it reduces government expenditures (including social transfers) in the tradable sector to be able to create sufficient primary surplus to service the debt. This clearly shows why government debt denominated in a foreign currency means either households have to tolerate austerity or public debt constraints the economy.

5.2.3 HZL - Policy with no interest in Income or debt, Focus on consistency

In this policy setting, government values consistency and takes no account of tradable income and little account of the level of debt. One would expect that there would be a marked difference between this fiscal policy and both the foundation and **HHV**. This focus on consistency of policy tends reduces the number of government defaults to less than 4% of the total and the total is some 75% of the worst case **HHV**. The consequence is that the households make up 95% of the defaulting. In this scenario, household defaults are much less costly to the foreign

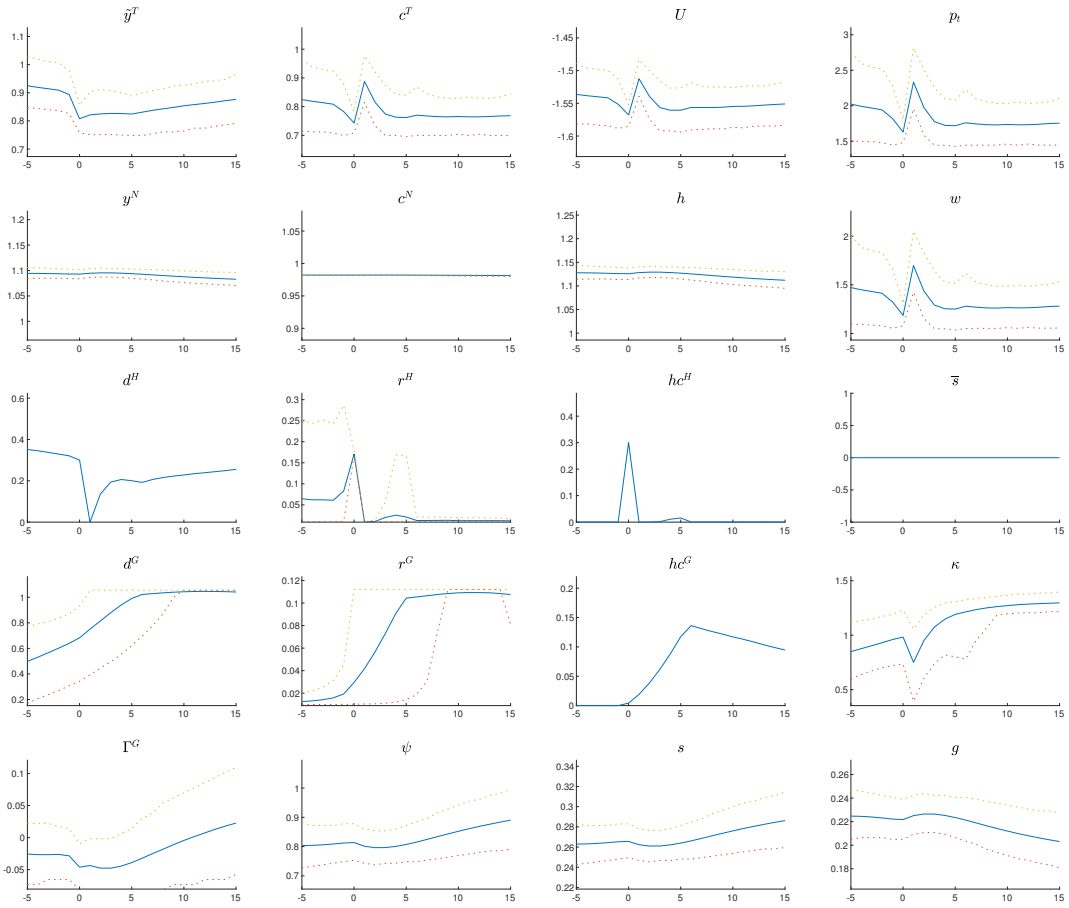


Figure 5.7: **HHL** - Household initiated defaults

investor, as a single event and tend to be more inline with the foundation scenario (Figure 5.9). With infrequent public sector defaulting and only marginal increases in private sector defaulting, then this 'hands off' approach seems to perform better for the economy **MMM** and certainly better than the more active policies of **HHV** and **HHL**. The critical factor over **HHL** is that it takes no notice of income changes and it makes such a marked difference in performance. This raises the question, if the government takes more notice of public debt then does that improve the situation? We reserve that question until later.

Our focus on the time paths is more on the private debt household defaults rather than the public debt as it occurs so infrequently. Inspecting Figure 5.10 that represents household defaults clearly shows a double dip recession in the tradables sector $\tilde{y}^T$. An interesting difference between the scenarios above is the double defaulting of the household on private debt d^H. The rebound after the initial crisis households can dedicate their income to consumption, albeit at the sanctions level, Quickly, the debt recovers boosting consumption and effectively overheating the economy, although tradable income is weak. This creates the second recessionary dip and another default. This repeats for another cycle, with a lesser peak and debt does not crash again, stability eventually occurs. However, in the domestic sector, those ructions in the tradables depress wages and there is a slow, inevitable decline in employment and output. We

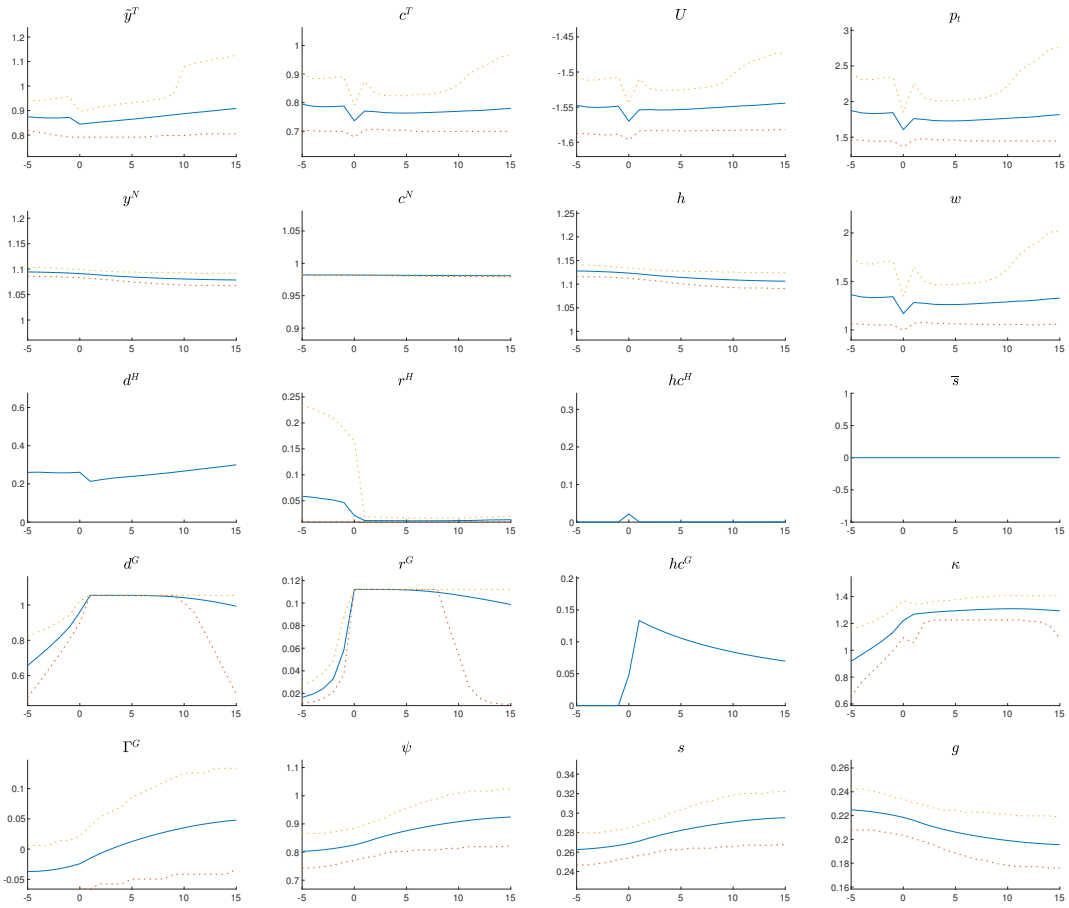
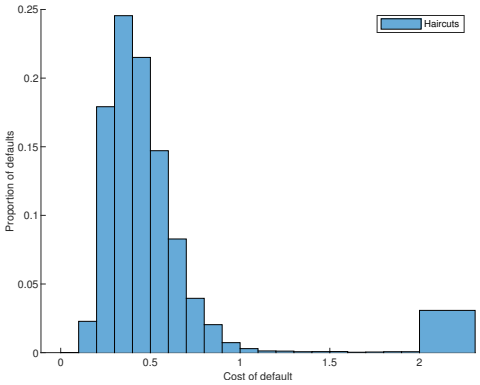


Figure 5.8: **HHL** - Government initiated default time-path sequences

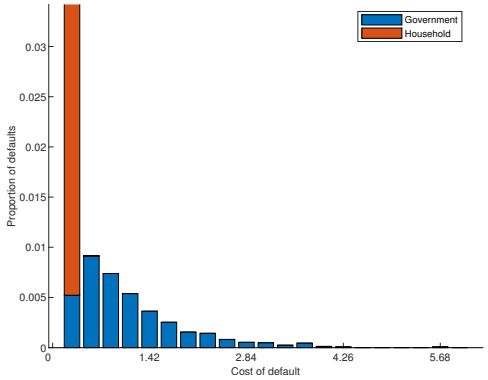
have already discussed how this drag on the domestic economy effectively slows the recovery. With depressed wages, then the economy's consumption does not recover and if one takes the demand drive supply, then this depresses employment. Over this short to medium run we can clearly see Keynes low order equilibrium. This is one aspect of the foundation model, that is it has two equilibria, one in good state and another in default. We show here that the process for moving from default to good state may be quick in debt, however the hysteresis creates this resemblance of a low order Keynesian equilibrium.

The response of government in these circumstances is somewhat more muted with the only significant impact is the primary surplus going negative. This boosts debt, however, not to the same extent as in prior scenarios. One aspect of this is that the movement of fiscal policy ψ is slow and only reflective of debt to move it out of the consistency track. This means that social transfers in the tradables sector decline with government expenditure, limiting the impact on the the primary surplus. As the core driver entering into the crisis is y^T declining and as the government does not take this into account in setting fiscal budget for the next period, therefore taxes remain static as does tradable social transfers. This protects the government, however, its lack of action makes the household experience a greater hit in the crisis and that crisis may occur more than once.

In the small number of cases where government default crisis, debt remains high and sustained



(a) HZL - Distribution losses for investors from all defaults



(b) HZL - Distribution loses for foreign investors separating out Government and Household defaults

Figure 5.9: **HZL** - Losses from default

with repeats in hair-cutting beyond the medium term. Conversely, the household fairs well in the circumstance with growing tradables and wages. The small amount of monitoring that the government does for debt slowly influences , however, not fast enough to allow the government to increase revenues and decrease costs. The persistence marked by the high level in the first term of the fiscal policy rule parameter creates hysteresis that causes a public debt crisis. In comparison to private debt, these are approximately 5% of the number of crisis across this scenario's simulation. The household experiences the upper end of the number of private debt crises, they tend to be deeper and repetitive. This is in contrast to **HHL**, where the government's response reduces the impact of a crisis. If one takes that government role is to protect the household then **HHL** outperforms **HZL**, even though it defaults more in the public sector.

5.2.4 ZHV - Government focus on income and debt, no consistency

This scenario is diametrically opposite to **HZL** in that consistency does not matter, only the response to income and debt, and those are very responsive in comparison to the foundation scenario **MMM**. Because it is both debt and income that matters, then some similarities to **HHV** should be apparent, the only difference should be that **HHV** has hysteresis in-build with consistency of policy whereas this has none. Some important questions are about the recovery such as is there a double dip recession and a slow path out in both tradables and domestic sectors. Because this reacts to debt, then one would expect that some of the effects of Haircutting to debt limit may be moderated. Furthermore, does this policy setting make it more stable or unstable for either the household or the government?

The distribution of cost of default and household drive that those default costs. In comparison with the foundation scenario, the costs distributions are similar in both the haircut and in the cost of default when accounting for the household. Bar the frequency, there is little difference between the foundation and this scenario, however, if a comparison with its diametric opposite policy then the distribution of haircuts tends to have a much longer tail in this scenario as well

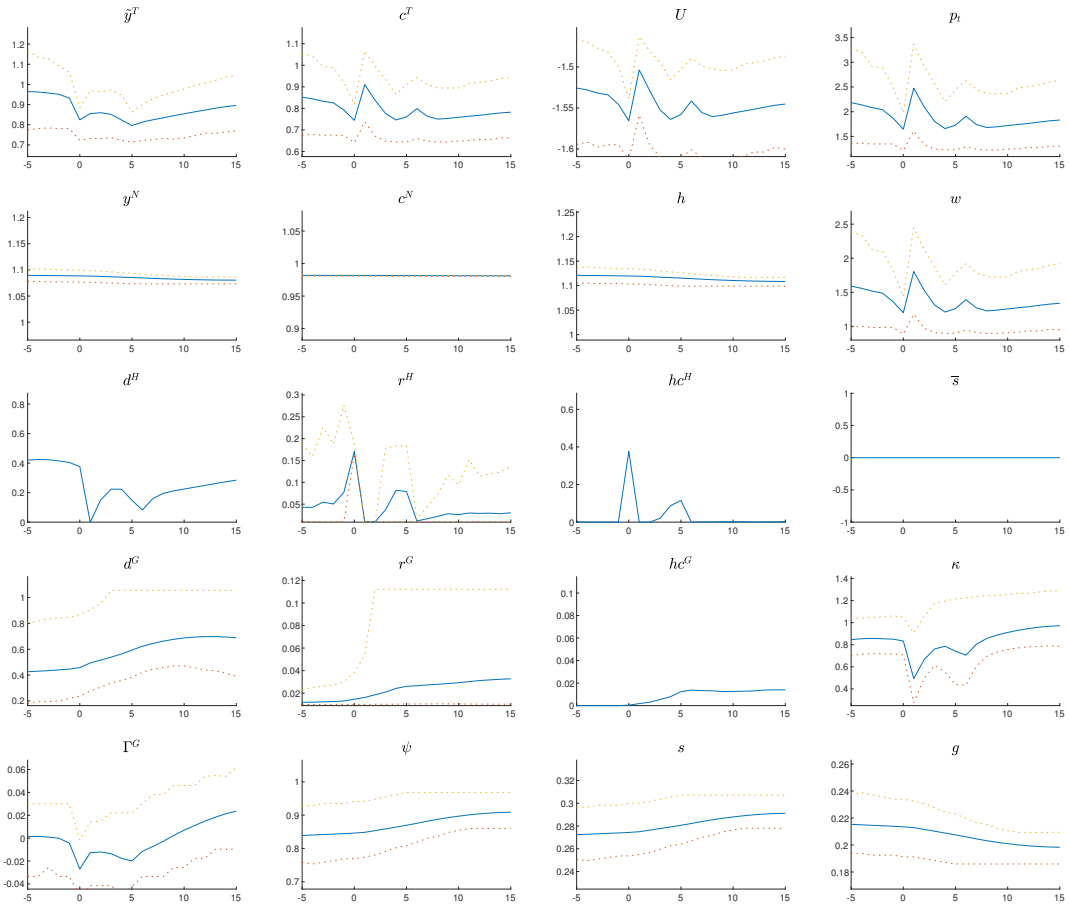


Figure 5.10: **HZL** - Household initiated Default time-path sequences

as being skewed to the left. Another aspect is that the household dominates the cost with many small frequent defaults rather than that of the government initiated crisis are infrequent however, higher levels of haircut. One can only draw that the haircut policy keep the public debt at the maximum and forces a repeat episodes for a long time. This is borne out by the bar chart in Figure 5.12.

An important question is about the trade-off of less government crises, and a slight increase in household crises and does this create an unstable household with more than one dip in recession? We observe in our simulation of this scenario the household crisis in Figure 5.13. We observe the same characteristic of crisis, bounce back and then a retrenchment, however, the retrenchment is a prelude to the lower consumption and real wages that will be sustained for the medium term. Although debt falls there is no apparent second private debt default in most cases hc^H. At the point of crisis, the primary surplus sharply goes negative forcing debt to rise quicker for a couple of periods. The quick response by government puts the the primary surplus Γ^G back into positive territory. However the change in the fiscal policy instrument ψ is a near constant increase. If one compares with that of **HHV**, then there are much greater swings in the fiscal policy which is counter-intuitive to the idea that the consistency parameter would prevent such extremes. One aspect is that the **HHV** does not experience the rippling effect in

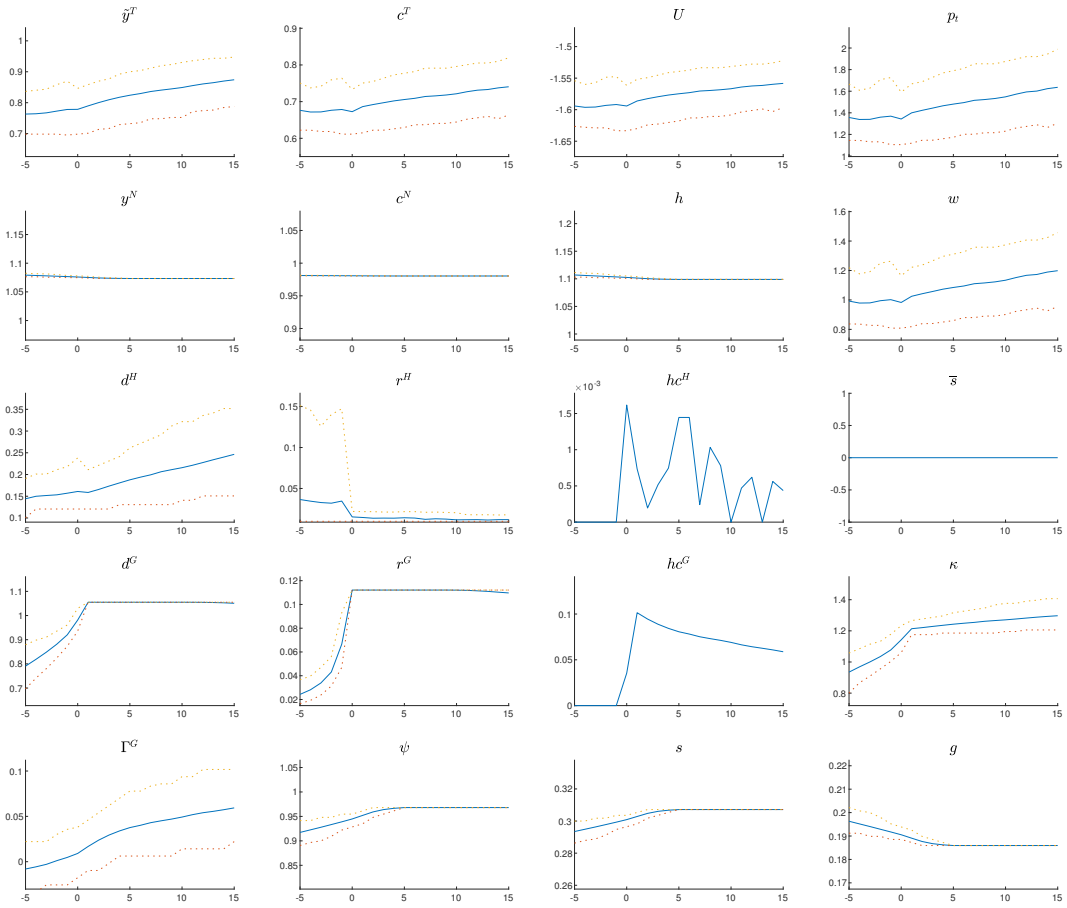
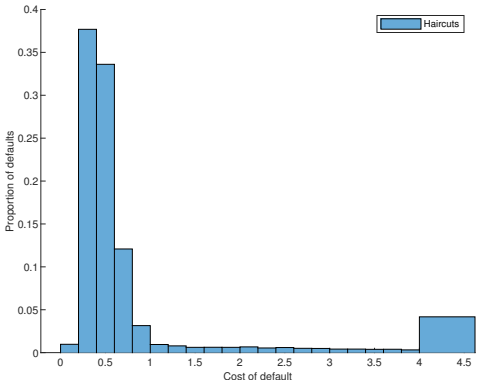


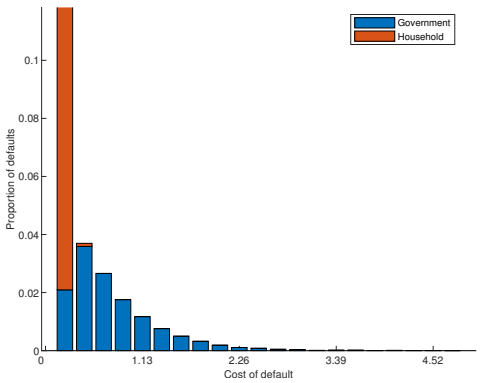
Figure 5.11: **HZL** - Government initiated default time-path sequences

consumption although the shape of $\tilde{y}^T$ is very similar. However, this policy setting does not have the more rapid decline in employment and seems to recover wages along a similar path. An interesting point it the total debt (or capital for the foreign investor κ). In this scenario the total debt continues to increase and tails off at a new higher level. whereas in **HHV**, it is much more hump shaped. One aspect of private debt crises is that public debt rises and does not seem to return in the medium run. It is more likely that the economy grows making the level of debt much less significant. In some cases, the household does generate a public sector crisis, however, this is very infrequent and the significance in hc^G is questionable.

Next is to consider the government. In Figure 5.14 we have adjusted the time-frame to include more of the start prelude to the crisis as this is significant to understanding government default under this scenario. The progressive decline in $\tilde{y}^T$ and as a consequence, c^T and the household de-leveraging d^H forces the government to run a primary deficit Γ^G thus increasing government debt. Both the tradables recession and increasing debt causes ψ to rise reducing social transfers and increasing tax revenues in an attempt to address the impending public debt bubble. The one period budgetary lag of policy implementation means that government does not act quick enough to prevent a crisis. Debt service effectively goes exponential with interest rates forcing debt over the tipping point where recover without haircut is not possible. The slow increase in social transfers is from the domestic sector as tradables social transfer is falling (it follows



(a) ZHV - Distribution losses to investors from all defaults



(b) ZHV - Distribution losses to investors broken down by Government and Household

Figure 5.12: **ZHV** - Distribution losses to investors

g in an expansionary economy). There is a decrease in employment and a quite rapid decline in wages that seems to bounce back slowly (however faster than the diametrically opposite strategy **HZL**). Post crisis , government is locked into the high level of debt and has to haircut. This is a feature of the hair-cutting policy **HCDL**. Unless government can generate sufficient primary surplus to service the debt and repay principle, it will remain stuck at this level. Increase in ψ the fiscal policy instrument flattens as debt reaches the NDL. Therefore only the recovery of tradable income would continue the increase in tax and decrease in social transfers and government expenditures. As we saw above, although infrequent, public debt debt crises tend to be long and persistent. This leads us to question of making all of the judgments on just debt level and income actually improves the situation over say a policy such as **HHL** where income matters and debt does not. Households tend to default less and the effects of government default are rather limited on the household.

5.2.5 ZZV - Government focus on debt only, no consistency of policy

This policy is a more extreme version of **ZHV** and could be considered a 'conservative' deficit hawks style policy where the level of government debt rules fiscal policy. With the fiscal ideology set to expansionary, this fiscal policy changes the dynamic into contractionary at high levels of government debt. This is though the mechanism of the fiscal instrument being increasing in public debt level and this in turn increases taxation and decrease social transfers and government expenditures. In a political context, one could draw parallels with the UK Conservative Government in 2010 focus on debt, or the New Zealand Government of 1991-1997, or the post crisis imposition by the IMF and others on Greece to reduce their debt levels. Such a policy combination as **ZZR** and **EXP** tends to make fiscal policy all about debt and drives potentially a austere programme by the government on the household. As we have already set out, this scenario, the frequency of government default is so small (343 out of 24484 sequences) that one could assume that this policy expunges government public debt crisis. However, this

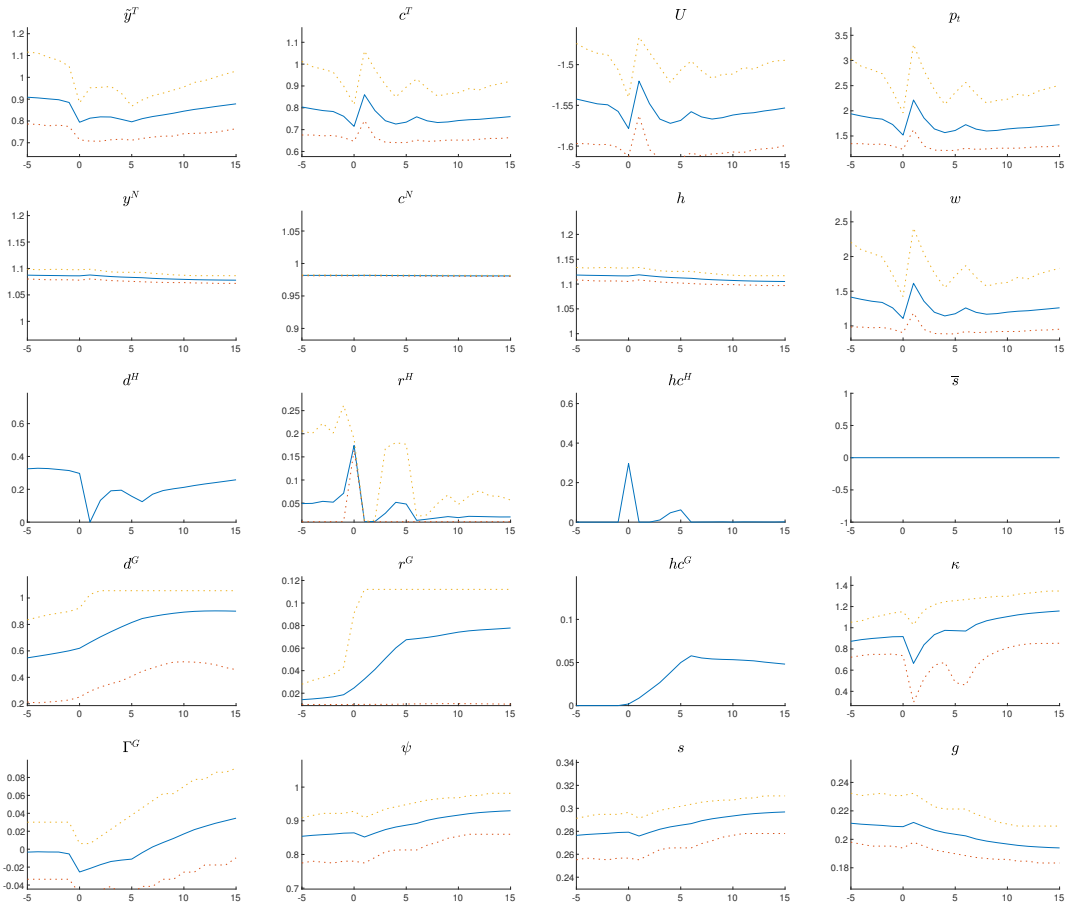


Figure 5.13: **ZHV** - Household initiated default time-path sequences

is at the expense of the household with a 15% increase in the private debt defaulting rate. Effectively, the government has traded it own risk and for that if the household. The mechanism here implies that government forces the household to create a significant surplus that ensures that the government's primary surplus is always sufficient to repay debt.

Although government does very occasionally defaults in this scenario, it is the private sector that creates the greatest losses more frequently for the investor Figure 5.15. One aspect of much macro-economic thinking is that public debt is the problem, largely ignoring the role of private debt. This policy effectively focuses all attention on public debt and ignores the role of private debt. This policy aligns very much with many neoclassical researchers theories on debt and crisis. in this model, we have had to push the envelope of fiscal policy to an extreme to achieve those theories with a neoclassical model.

Our focus is on the household time path during a private debt crisis starting with sequence summary household defaults (**HDNBA**) that we illustrate in Figure 5.16. We include the time path for government crises (**GDEFA**) for completeness Figure 5.17, however the infrequent nature of government debt crises may not give a clear indication of the how a crises unfolds and what its outcomes are. Referring to **HDNBA**, we clearly see that the economy experiences multiple default events and crisis to a more extreme level that that of any we have looked at

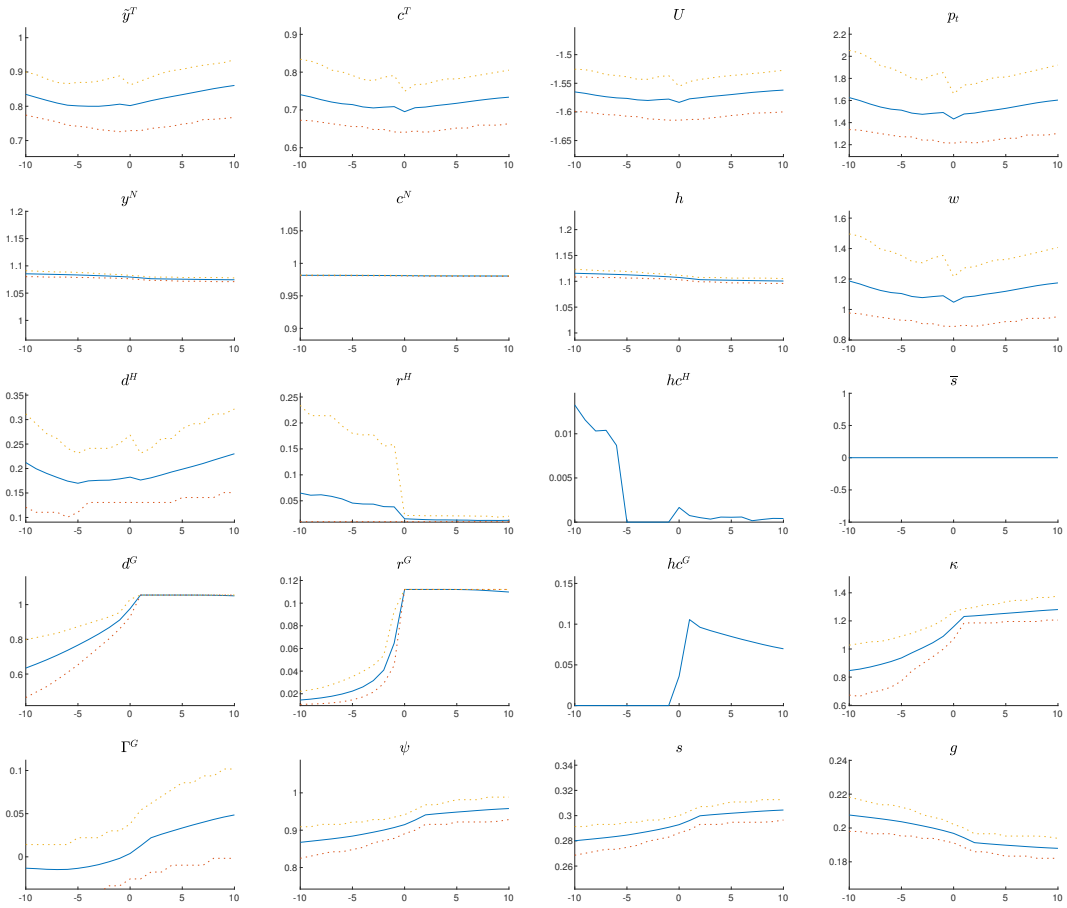
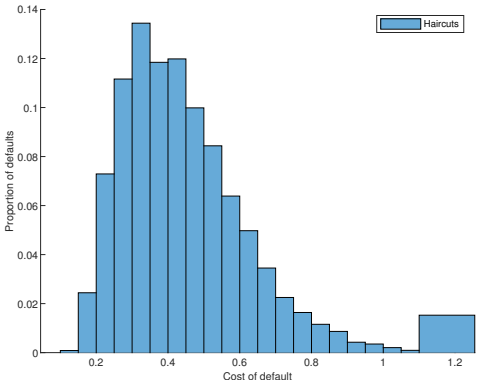


Figure 5.14: **ZHV** - Government initiated default time-path sequences

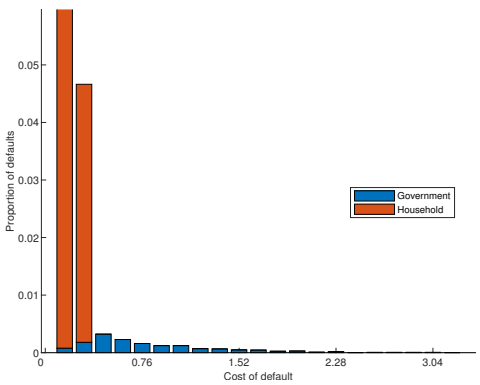
so far. Removing the effect of tradable income has a dramatic and significant effect on the household.

Contrasting between **ZHV** and **ZZV** we can clearly observe that the government's lack of intervention not only increases the chance of crises it also increase the length and depth of the crises. Before the crisis, government is running a not unexpected surplus Γ^G even in a declining income economy. It only receives a negative primary surplus when consumption and income collapses with the default private debt. From s (combined social transfers), there is no change in response to either pre-crisis or post crisis. There is little movement in the fiscal instrument ψuntil debt starts to climb. Therefore there is no change in policy throughout the first stage of the crisis, and post crisis, that policy is to create greater primary surpluses to prevent government default by increasing tax and reducing tradable social transfers. This creates a second and third dip in household consumption, and the effects resonate into the domestic sector with wide movements in real wages that follow price.

Wages take the brunt of the crisis in the domestic sector, however, unemployment increases gradually as government spends less in that sector. In passing, the public debt crises in Figure 5.17 seems largely driven by a recovering economy where government debt has hit the tipping point. This is likely to be as a result of instability in the private sector not generating sufficient tax revenues, hence primary surpluses, to keep the government away from the tipping point. The one period lag in the budgeting process causes the government not to be able



(a) ZZV - Distribution losses to investors from all defaults



(b) ZZV - Distribution losses to investors broken down by Government and Household

Figure 5.15: **ZZV** - Distribution losses to investors

to implement an austerity programme fast enough in some very limited cases.

5.2.6 ZZL - Government is agnostic to debt and income

This is our final scenario for this chapter, it is the diametric opposite of the first scenario **HHV**. It is completely non-interventionist other than a mild response to public debt. Therefore it could be likened to **ZZV**, with a lesser focus and ideological drivers. It still fits on that austerity spectrum of policies in that it does not account for tradable income and takes only debt as its policy setter. It is an interesting contrast to **HHV**, the highly interventionist economy and **ZZV** as a measure of this ideological driver. Importantly, this ideological spectrum between **HHL**, **ZZV** and **ZZL** almost represents the political-economic ideological spectrum from what is 'left' social-democratic, possibly Keynesian interventionist and protecting the household to the more 'right' conservative, possibly Austrian School deficit 'hawks' that insist government needs to maintain a balanced budget, low debt.

The first element to contrast is the length of the crises, as there are insufficient **GDEFA** public sector crises we only consider the private sector as we illustrate in Table 5.5. Not unexpectedly, the majority of household defaults are short as they are with other scenarios. Likewise, the cost of default Figure 5.18 to the foreign investor is heavily skewed to the left indicating that each event is a small cost and as before government forms the majority of the long tail. In this case The tail is low and flat with a very sharp peak for households. As the number of public debt crisis is small, drawing any conclusions from them is somewhat problematic.

The important aspect is the effect on the time path for the economy. This non-interventionist policy shows though with the only small change in the fiscal instrument $\psi$and that reflects into the income and expenditures with only small changes to the rates. This has an amplifying effect

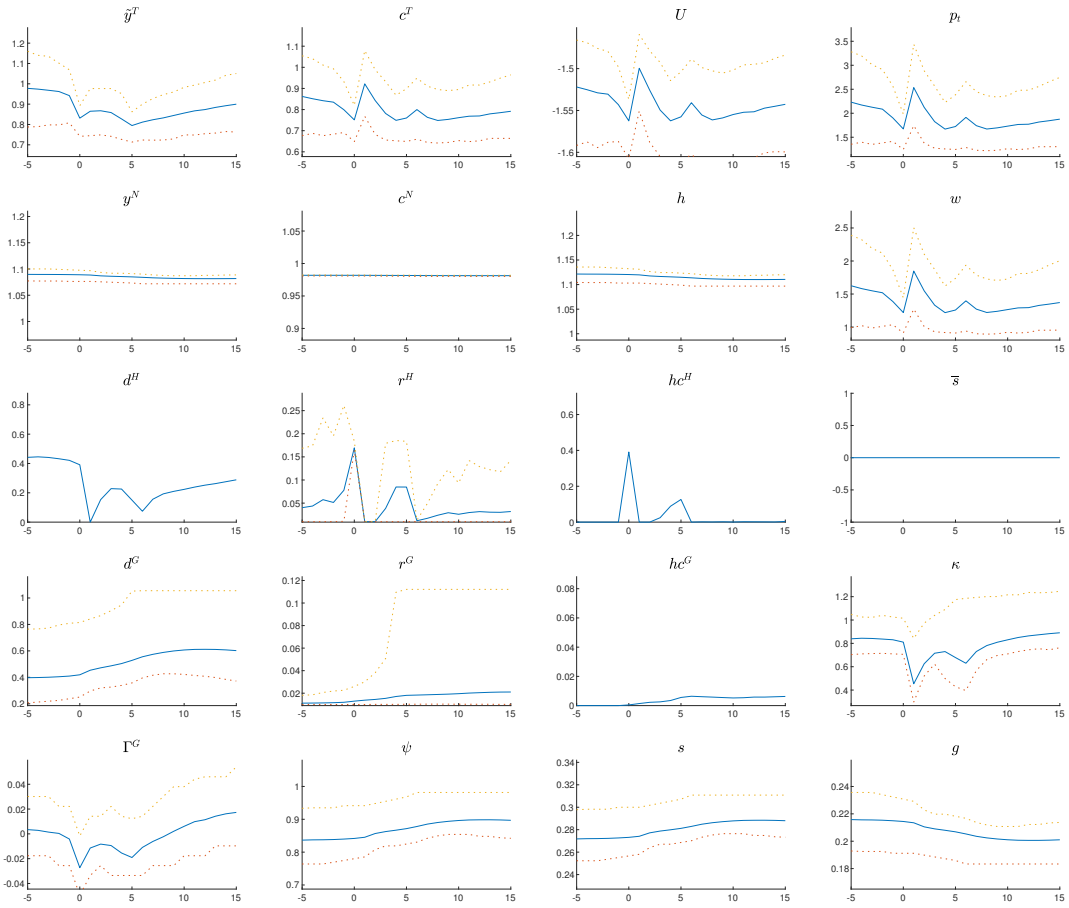


Figure 5.16: **ZZV** - Household initiated default time-path sequences

to the primary deficit in that there is no movement in the fiscal budget and the government absorbs the deficits with debt. For the household, such inaction means that they focus solely on their own debt, income and consumption problem and do not need to bare the burden of additional taxes and declining social transfers in the same way as with **ZZV**. One aspect of taxation is that it has a moderating effect on a increases in consumption though both the income and consumption tax channels.

This may lessen the spike and a detailed comparison between **ZZV** and **ZZL** indicates that **ZZV** response to debt is too slow to be effective in this way. The spike is for only a couple of periods and public debt takes time to climb sufficiently to affect the immediate crisis. In comparison with **HHV**, and **HHL**, the most interventionist and the later the most 'benevolent' to households, these only generate a single spike after default and the economy stabilises quickly. Although **ZZV** and **ZZL** tend to be the policies pushed on developing nations when they get into debt crises, this model indicates that they are more destabilising to the private sector as it has to bare the risk rather than the government. The government time path, Figure 5.20 we include for completeness. It has striking similarities to **ZZV** with a more moderate response to public debt and as we have already commented, a more pronounced primary deficit Γ^G.

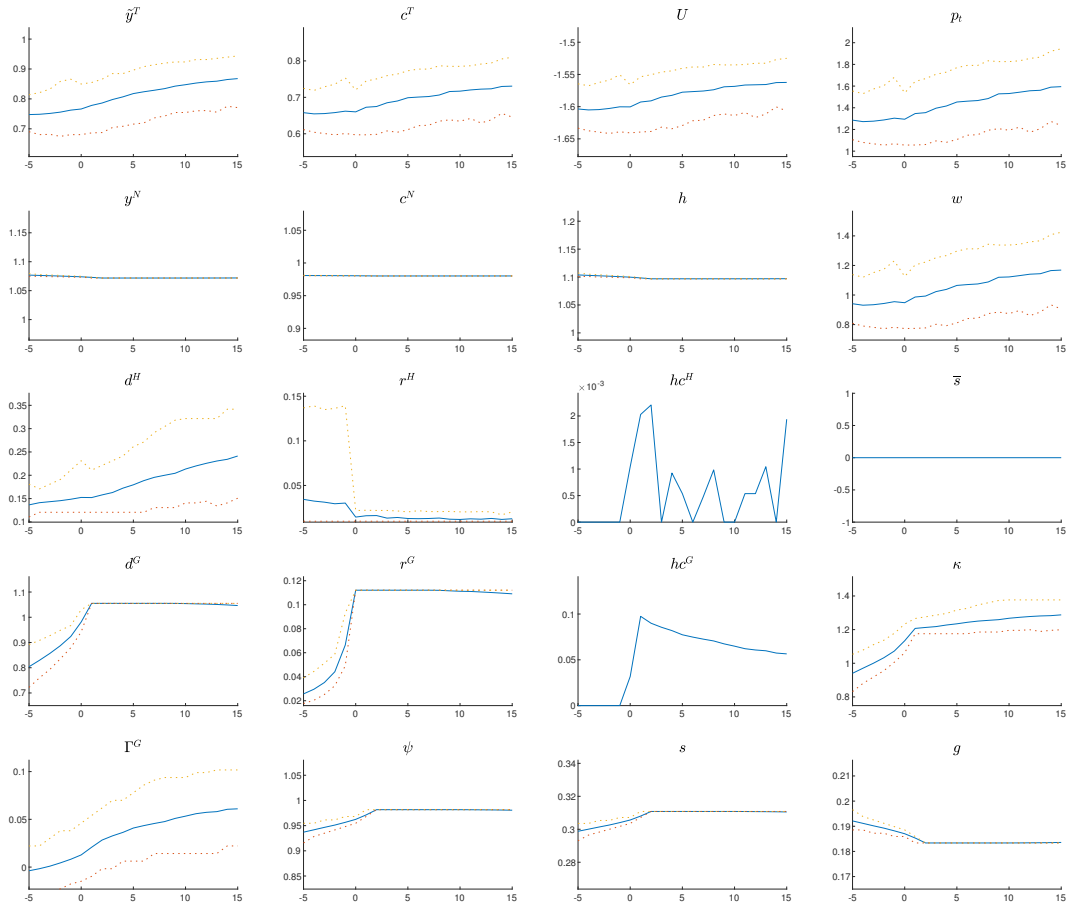
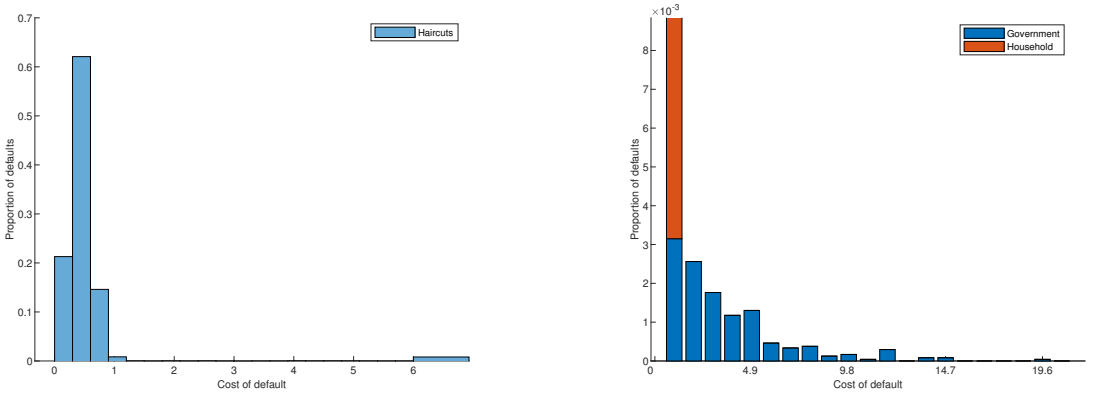


Figure 5.17: **ZZV** - Government initiated default time-path sequences

5.3 Cross Scenario Comparison

Our final section for this chapter is a cross scenario comparison on the two key crises initiators, namely private debt summary and public debt crises summary. We already note that some scenarios fiscal policy settings lead to double or triple dip recessions and that recovery in the domestic sector can be slow with real wages seemingly stuck at a new level. We consolidate all the time paths across all scenarios under consideration for fiscal policy in one chart Figure 5.21 for easy comparison. The left hand column is the foundation scenario and we order the columns from the left in the same order as above. We can say that , bar the foundation scenario, the left hand columns are more interventionist whereas the right hand columns the government leaves the private sector to its own means.

First to note is that the three scenarios with policy settings **MMM**, **HHV** and **HHL** show similar paths for the private sector, that is there is the crisis, then an up-tick in consumption as a result of not needing to service debt, and then a period of stability with a gradual increase in total consumption. One contrasting difference between these three is that wage and labour have slightly different paths **HHV** tends to have greater wage deflation immediately after the up-tick in consumption then gradually returns. The rate of of those becoming unemployed is much more pronounced **HHV** leading to a fall in output. Partly, the increase in taxes and the decrease in social transfers (tradables, domestic increases) and government expenditure with a



(a) ZZL - Distribution losses to investors from all defaults

(b) ZZL - Distribution losses to investors broken down by Government and Household

Figure 5.18: **ZZL**- Distribution losses to investors from defaults

reduction in real wages depresses demand. We do not observe this effect in the other scenarios, rather the decline in employment is much more gradual.

One important difference between the left and right hand columns is the double dip recession, in **HZL** and **ZZL** the second recession is deeper than the first. Both of these have the characteristic that they take little notice of fundamental economic variables such as income and debt. This is somewhat evident in the ψfiscal instrument that sees a gradual incline upwards in response to debt. Note in **ZZL**, the level of government debt is almost at the lower end of the range, whereas if one takes the consistency (**HZL**) into account, then debt during a crisis is much higher. Both these settings, government does nothing to a respond to a recession and to provide additional income to the household when in difficulties. Our model shows that such policies make the situation worse for the household that the foundation scenario fiscal policy.

We demonstrate that the ideology and principle focus on public debt in these two scenarios is damaging to the economy. The adoption of this style of policy tends to have an association with a politically right leaning demonstrating a hawkish view to public debt and a libertarian view of government. This is contradictory to the view expressed by Keynes. This mantra has gained considerable traction with international NGO across the world and is imposed on many developing countries and those in the southern end of the European Union. As we show in Chapter 2 this mantra derives from academic theories that are not supported by the evidence nor banking practice. We show that such policies are counterproductive to the well-being of the household and the economy in total.

Conversely, those policies on the left Figure 5.21 tend to recover the economy without the double dip at the expense of public debt. In all cases, public debt increases by the natural effects of a reduction in private sector income and consequential reduction in consumption. Furthermore, we show that the household attempts to deleverage, further reducing consumption. In time of uncertainty, households seek to reduce their debt and with pressure from financial institutions deleveraging occurs. This deleveraging can create the Fisher debt deflation and for firms, the deficit aggregate demand causes them to divest labour and eventually capital. In

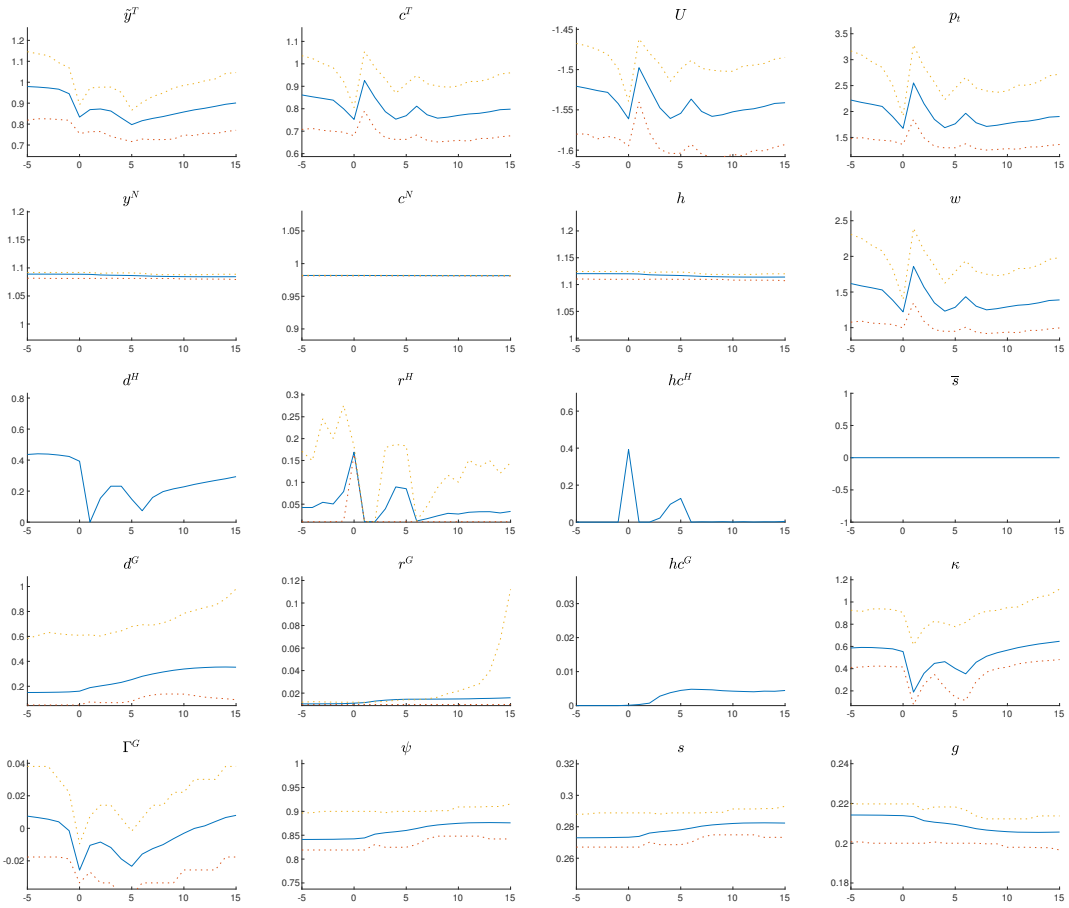


Figure 5.19: **ZZL** - Household initiated defaulting time-path sequences.

the scenarios **HHV**, **HHL** and to some extent, **MMM** government responds to the shortfall in income with social transfers.

We see in **HHL**, where government focus is on consistency and income, the response smooths out the path for the household. Similar paths are in **MMM** and somewhat surprising **HHV**. The aspect with **HHV** is that initially, the government provides social transfers into both the tradables and non-tradables, however as debt increases, it increases taxation and reduces government expenditures and tradable social transfers. The domestic sector tends to pick up the additional tax revenue in social transfers creating an quicker movement upwards of wage rate. This quick response does tend to narrowly avert a government debt crisis. If one takes the Keynes approach then some policy setting for debt between **HHV** and **HHL** is likely to provide both protection for the household and limit the possibility of a public debt crisis.

Juxtapose to the Keynes role of government, the more austere policies of **ZZL** and **ZZV** fully protect the government. For the foreign investor in government bonds, this provides the best outcome, however the cost on the household of more frequent multiple dip recession with long slow recovery that have more than economic implications.

A comparison of public debt crises across all of the scenarios is in Figure 5.22 were we see that only the most highly interventionist fiscal policy rule **HHV** reduces debt within a reasonable

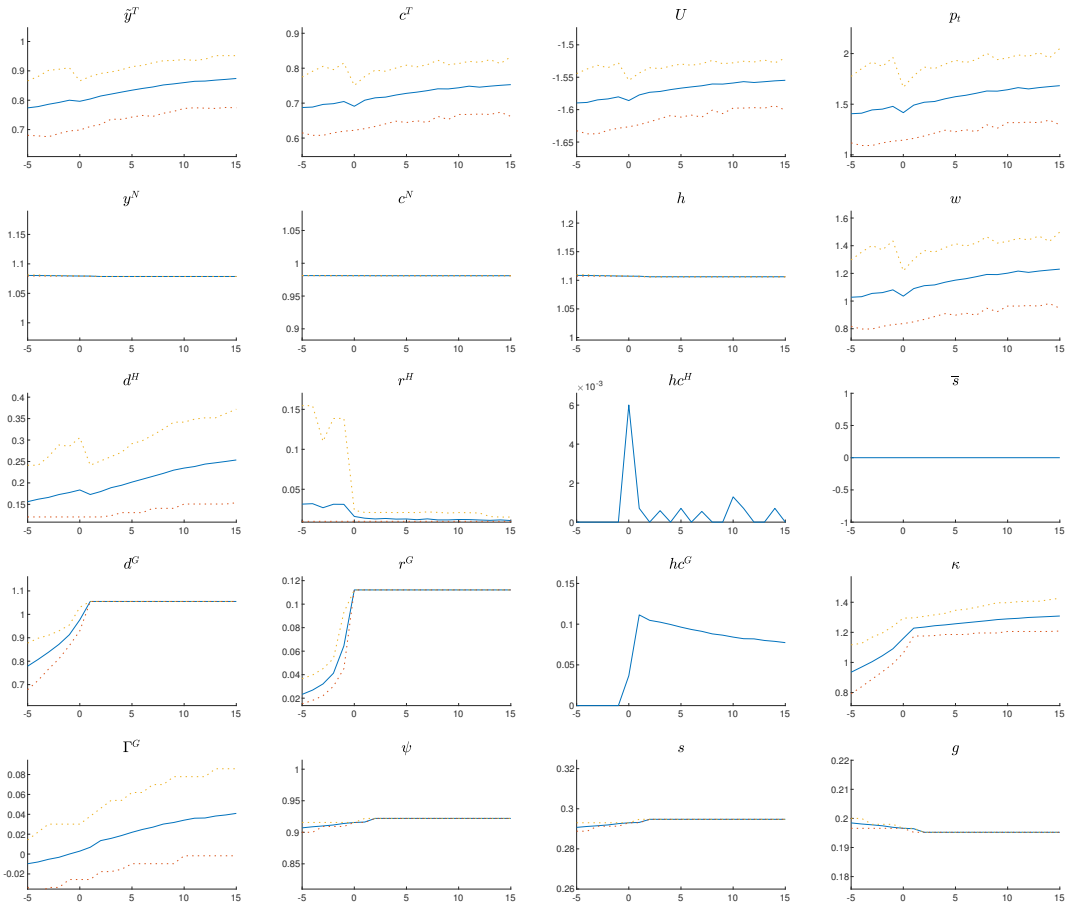


Figure 5.20: **ZZL** - Government initiated defaulting time-path sequences

time-frame. This somewhat reflects the desire of foreign investors or those NGO's that come to rescue a nation to impose strict fiscal policies that increase tax revenues and significantly reduce government and social spending. However, this is done at the expense of the household that reduces its tradable consumption and suffers significant reduction in real wages. Furthermore, this generate unemployment. What seems to be a good strategy for the government to quickly get government debt under control is a disastrous strategy for the private sector. If these effects were short lived, then maybe an economy could live with the short term cost. Nevertheless, **HHV** style policy has a long term stagnation in the domestic sector. There are similarities here between the UK, Greece and Ireland on different scales. Another aspect that we do observe is deleveraging in the private sector as incomes are suppressed. Again this pattern follows the austerity style programmes evident after the 2008 crash.

The alternative is the more Keynesian style where government that tries to ensure that the household is able to keep spending by not increasing taxation and maintaining a level of social transfers. However, this is at the cost of high public debt and if a government is constrained by foreign investors then it is likely to default or have to negotiate a package. From second column left (**HHV**) which is the most interventionist the the right hand column (**ZZL**) covers nearly the dichotomy between a Neoclassical neo-liberal Ideology practised in many countries from the late 1980's onwards to that of a more Keynesian approach certainly practised during the Great depression and throughout the 1950's.

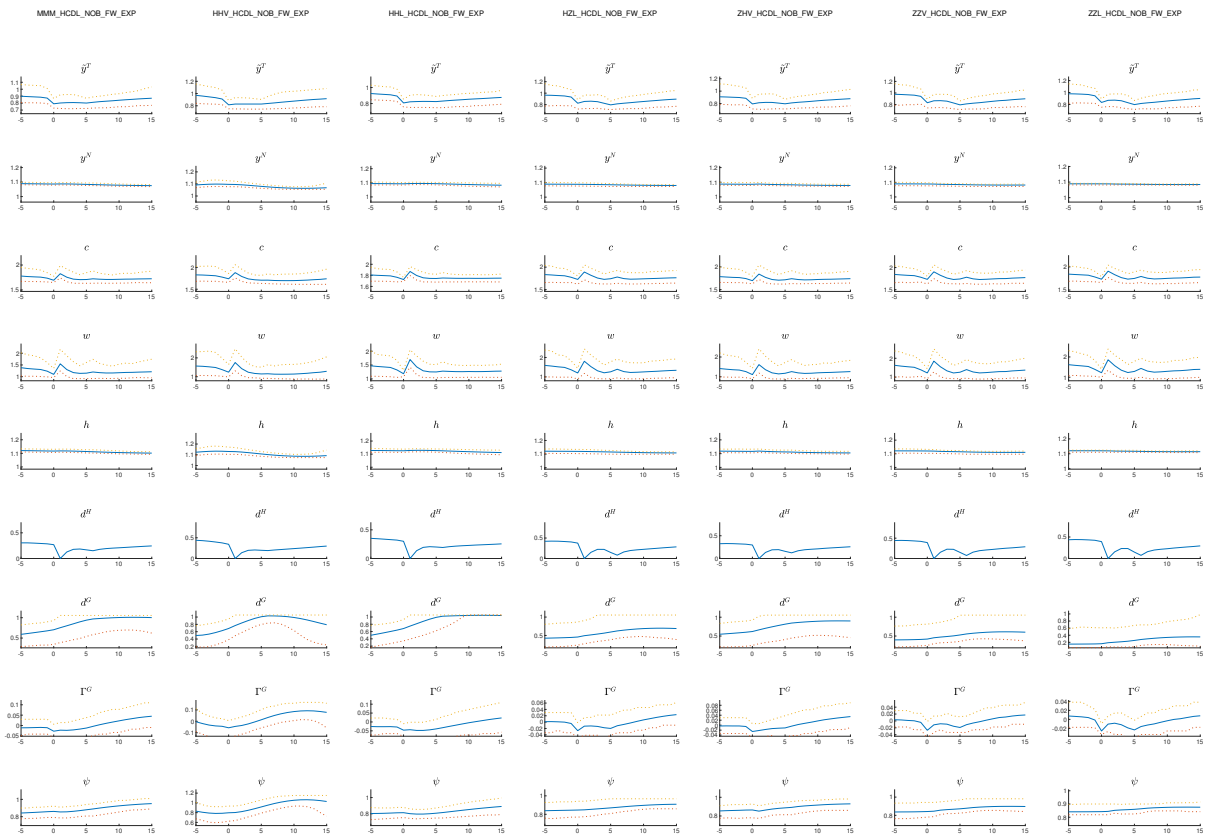


Figure 5.21: Comparison of Scenarios for household initiated defaults.

5.4 Conclusion

In this chapter, we explore the range of possible fiscal policy rule parameters, particularly at the extremes. Using the extremes allow us to explore both the flexibility and possibilities for this style of fiscal policy rule tests the resilience of the model and possibly explantation for particular economic behaviours that we observe. For example, the double dip recession that we so often observe in the real world, it somewhat complex to model as the feedback loops do not necessary induce the second or third dip. Furthermore, the fiscal policy rule parameters may change quite dramatically in a crisis situation. What may be the norm for an economy in a good state, may not be the most appropriate in a crisis. Such decisions are largely political, therefore, difficult to model. Our approach is to model the different fiscal policy extremes and contrast them against the norm or middle ground.

What we have is the fundamental difference in ideology and where government focus lay. This clearly demonstrates that the more interventionist on debt fiscal policies, particularly when mixed with a focus on tradable income may be able to stabilise public debt quickly, however it does so at the two costs. First the private sector response is recessionary in both trade and domestic sectors and household response it to deleverage. This creates debt deflation and stagnates the economy. The other cost is that the economy is generally more unstable with a greater number of default sequences.

Another aspect to consider is if the government is trying to protect debt then it is effectively transferring the risk to the household that now has to carry the debt and risk of default. The

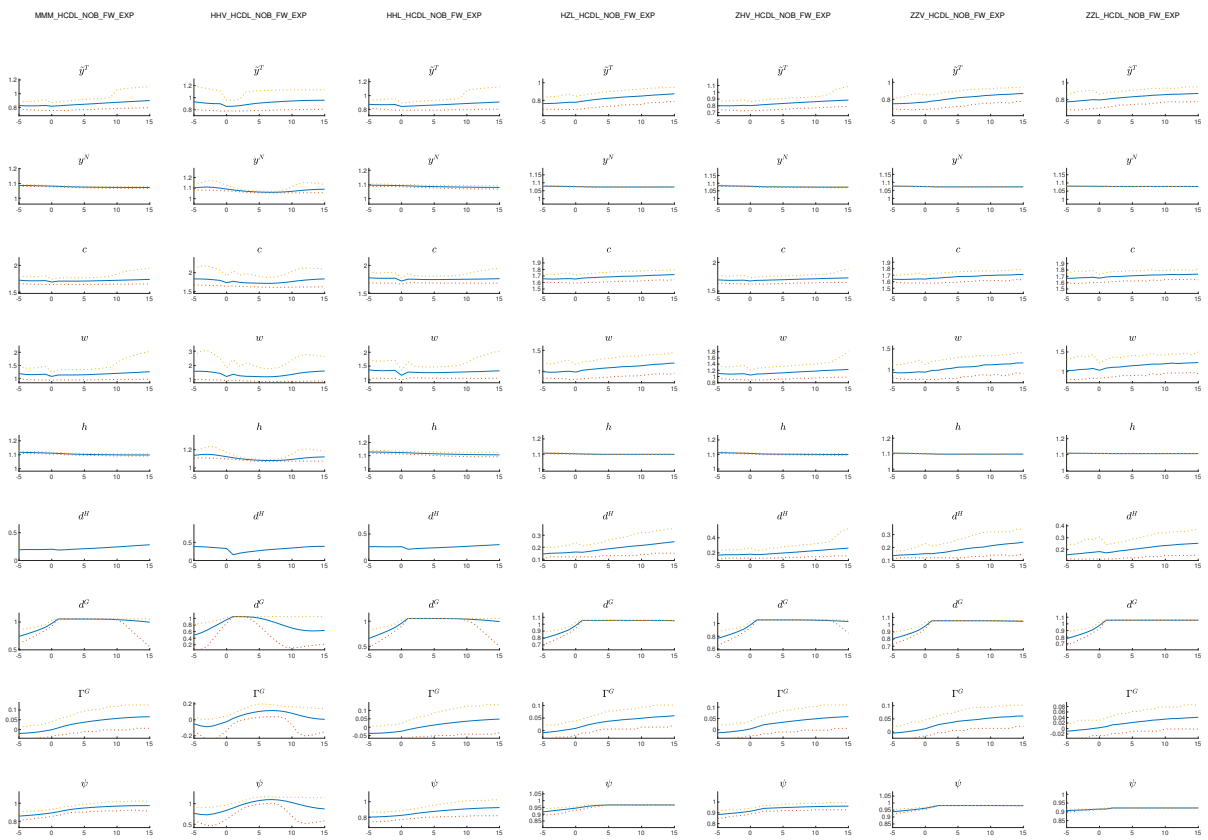


Figure 5.22: Comparison of scenarios: for government initiated defaults (**GDEFA**).

worst cases are those with the interventions that focus on consistency of policy and public debt. These create the greatest level of instability in the household. When is less influenced by the key economic indicators and the need to be consistent, then it generate consistency in that the number of public debt defaults largely disappear and household defaults remain about the same. Only when the government is focused on consistency and income and largely ignores debt does the number of household default fall. Nevertheless, this is at the expense of government defaulting much more frequently.

Regardless of the fiscal policy rule, the private sector consistently default more frequently than government and the less that government worries about public debt the more likely it is to be stable. However, when in a public debt crisis, governments that ignore the debt take a long time to recover. This would imply that such a government would be better to haircut the debt to a much lower level and effectively re-baseline the economy

Fiscal policy is as much a political choice as it is an economic one. The role that the political ideologies say is for government is important to understand in those political choices for economic policy. Although this is a simple rule to apply to an economy, we have demonstrated here that the flexibility of the fiscal policy rule provides a wide range of scenarios to discuss as policy. This could contribute to the discussion on what is the role of government. Is it, at one end, it acts as a social safety net, or the other end, more self interest than support of households.

We can see that austerity has a significant negative impact on the economy as the household experiences instability and a long period of depressed outcomes. Both real data and this model

confirm that finding. This creates uncertainty and most likely in the real world, a much more short term view. This is reinforced by the post 2008 crisis, those countries that were impacted the most and then adopted austerity as a response to debt have declining social outcomes and do not have the resources to survive another crisis without significant assistance.

The neoclassical focus on public debt and to neglect private debt misses the point. The evidence and these models show that private debt plays a significant role in the economy and cannot be willed away with quantity theory of money. Replace the foreign investor with the banking system that can create and destroy money, lends based on risk, then the model becomes more like a sovereign currency model. Money matters.

Chapter 6

Bailing Out

'....shall have a new birth of freedom—and that government of the people, by the people, for the people, shall not perish from the earth' - *Lincoln, Gettysburg Address, 19th November, 1863*

'Gouvernement du peuple, par le peuple et pour le peuple' ('government of the people, by the people, and for the people') - *Constitution of France, Fifth Republic*

6.1 Introduction

One critical aspect that the our foundation model and most economic models do not cover the government bailing out the private sector. Here we introduce government bailout of the private sector as a mechanism to limit the effects of a crisis. In the past 100 years, government in the OECD has stepped into bailing out the private sector over 20 times, some quite small interventions, others large such as the 1933 New Deal, the 2008 UK, US and European response to the financial Crisis, 2020 response to the SAR-Cov-2 Pandemic. Each one has quite different dimensions and methods of delivery and who they target. However, they all have one thing in common, there is a transfer of wealth from the government to the private sector resulting in public debt increasing. These transfers tend to be limited to a few months and are purported to be largely unsustainable in the long run. We extend the foundation model with the addition of a unique bailout mechanism that calculates the funds required to stop the private sector deepening the crisis within the constraints of its own budget. We also include the ability for foreign investors or for the government to set covenants on the bailout as a function of the level of debt.

In Chapter 5 we discuss the fiscal rule policy settings and consequences on households. This was both in taxation and social transfers noting that if government is appreciative of some economic indicators over others then the effect on the household in a crisis can be dramatically different. A few scenarios, the government provides additional funds to the household though the social transfers channel and reduces taxation when income is low. However, tradable income is a proxy for the state of the household and does not account for its current level of debt. As we discuss in Chapter 2 private debt has a significant role in crises, therefore, the mechan-

isms in the foundation model are potentially insufficient. We have seen many different ways of directly and indirectly of governments intervening in the economy to prevent or limit the effects of a crisis. We discuss these further below. We refer to bailout as a general term that covers any direct intervention by the government using its funding resources to fund part or all of the private sector so as to prevent or mitigate a crisis. Therefore bail-ins, equity injections, refinancing/structuring, a grant, wage subsidy, a temporary universal basic income, transferring bad debt at full face value and many other mechanisms as a bailout if it involves government using its funding resources.

What motivates a government, how it goes about identifying a crisis the methods use we discuss here in a set of simple questions with rather more complex answers. First, why intervene a crisis. Although, in part we have contextualised this discussion above, we now need to look deeper into identifying that a country is just about to go into crisis, some of the goals and motivational aspects in both the short and medium term. Second, identifying that the country is in crisis and why we cannot forecast them accurately. Third, if a government intervenes, how does it go about intervening to achieve its goals. Finally, what actors in the economy does the government focus on and finally does bailing out create some expectation in the future of government intervention.

6.2 Foundation Model and Scenario Extensions

6.2.1 Decisions on Debt and Bailout

In this model, households internalise their own debt, however they do not consider the overall debt position of the country, nor the level of government debt. This is contrary to the normative assumption that Ricardian households would expect that increases in government debt would result is some form of austerity measure at a later date. The Ricardian assumption requires a level of household sophistication households in the understanding of taxation, government finance, and government debt to forecast accurately the consumption level and savings. One could argue that, particularly in periods of stability, households are largely not concerned with government debt. Furthermore, when a crisis looms large, households may seek a bailout to prevent default or government sees a potential debt crisis in the private sector and attempts to prevent it without considering the longer term impacts.

Households may understand the cost of default in terms of the loss of output, they do not comprehend the consequential loss government revenue and the ability to service debt. We propose that households consider only themselves and government assesses the 'state' of the overall economy determining the level of social transfers and debt that is appropriate to maintain stability. If a private sector debt crisis is about to unfold, government, either at the initiation of the private sector or its own self interest in preserving revenues steps in with a bailout (an elevated level of social transfer). We will demonstrate that as crises looms, then government may be forced to bail out the households to prevent a loss in tax revenue and a consequential default on its own part.

We start with the household debt decision making followed by the government deciding if bailout is required, and the level of bailout.

6.2.2 Bailout Modelling

The foundation model can indirectly influence the household behaviour though taxation and social transfers, however, it cannot directly affect the household's decision to default or not. We treat the default event as the crisis point where both government and household become aware that the current private debt position is untenable. To achieve the direct transfer, we create an additional variable $\overline{s_t}$ indicating additional social transfers that are necessary to prevent the household from defaulting. If the decision path set out in section 4.6 determines that the household is about to default then the government needs to determine how much additional income the households needs to prevent default whilst not defaulting itself or breaking any policy rules regarding the level of debt. Starting with the simple case, the first step is to solve the problem set out in Chapter 3 that duplicate here:

$$I_t^H = \underset{m\in\{0,1\}}{\operatorname{argmax}} \left\{ m v^{gc}\left(d_t^H, y_t^T, h_t, \psi_t, \overline{s_t^T}\right) + (1-m)\, v^d\left(y_t^T, h_t, \psi_t\right)\right\} \tag{6.1}$$

where $I_t^H = 1$ is no default, that is remaining in good standing. The utility from household is not going to default (we assume that if the the utility from remaining in good standing is the same as default, then the household does not default):

$$\begin{aligned} v^{gc}\left(d_t^H, y_t^T, h_t, \psi_t, \overline{s_t^T}\right) &= v^d\left(y_t^T, h_t, \psi_t\right) \\ \text{Subject to} & \\ \overline{c_t^T} &= \frac{\left(1-\tau_t^Y\right) y_t^T + q_t^H d_{t+1}^H - d_t^H + s_t}{1+\tau_c} \\ s_t &= \frac{s^T}{\psi_t} + I_t^{H*}\overline{s_t^T} \\ \frac{H_h\left(h_t\right)}{F_h\left(h_t\right)} &= \frac{\left(1-\psi_t\tau^y\right)}{\left(1+\psi_t\tau^c\right)} U_c\left(\Psi\left(\overline{c_t^T}, c_t^N\right)\right)\Psi_2\left(\overline{c_t^T}, c_t^N\right) \end{aligned} \tag{6.2}$$

Where $\overline{c_t^T}$ is the consumption with bailout and $\overline{s_t^T}$ is the social transfers necessary to prevent default where $s_t = \frac{s^T}{\psi_t} + I_t^{H*}\overline{s_t^T}$.

The household may default, that is $I_t^H = 0$ and needs to consider the value of defaulting and then returning to good standing with probability θ^H. Hence the value of defaulting:

$$v^d\left(y_t^T, \hat{h}_t, \psi_t\right) = \max_{\left\{c_t^T, c_t^N, h_t\right\}} \tag{6.3}$$

$$\left\{U\left(\Psi\left(c_t^T, c_t^N\right)\right) - H(h_t) + \beta E_t\left[\theta^H v^g\left(d_{t+1}^H, y_{t+1}^T, \hat{h}_{t+1}, \psi_{t+1}\right) + \left(1-\theta^H\right) E v^d\left(y_{t+1}^T, \hat{h}_{t+1}, \psi_{t+1}\right)\right]\right\}$$

subject to

$$c_t^T = \frac{\left(1-\psi_t\tau^y\right)\left[y_t^T - L\left(y_t^T\right)\right] + \frac{s^T}{\psi_t}}{1+\psi_t\tau^c}$$

$$c_t^N = F(h_t) - \frac{g^N}{\psi_t}$$

$$\frac{H_h\left(h_t\right)}{F_h\left(h_t\right)} = \frac{\left(1-\psi_t\tau^y\right)}{\left(1+\psi_t\tau^c\right)} U_c\left(\Psi\left(c_t^T, c_t^N\right)\right)\Psi_2\left(c_t^T, c_t^N\right)$$

Note that $\overline{s_t^T} = 0$ in the default state as this only occurs if the government is successful in bailing out.

When the household defaults, then tradable consumption is reliant on the revenue from the attenuated tradable output, social transfers less tax on output and consumption. . This implies $c_t^T = y_t^T - L\left(y_t^T\right) - g^T$ The value of being in good standing is a choice between value of continuing in good standing and the value of defaulting:

$$v^g\left(d_t^H, y_t^T, h_t, \psi_t\right) = \max\left\{v^{gc}\left(d_t^H, y_t^T, h_t, \psi_t, \overline{s_t^T}\right), v^d\left(y_t^T, h_t, \psi_t\right)\right\} \tag{6.4}$$

If the result of solving these equations by increasing $\overline{s_t^T} > 0$ until (6.2) is satisfied and that there is no desire to default, namely $I_t^{H*} = 1$. An important issue to discuss is who initiates the bailout. Does the private sector seek assistance from government or does government identify the impending crisis and act? In the case of the 2008 crisis, the UK's initial response was from the regulator identifying that some financial institutions were very close to the prescribed limits and unlikely to be able to recover successfully. They were running out of capital and liquidity at an accelerating rate and a crash of the financial sector that would spill over to the real economy was highly likely. Here the government stepped in, 'persuaded' the banks that they needed refinancing before the system crashed.

In the US, it is maybe a little less clear, however, with the bankruptcy of Lehmans after a period of uncertainty, and with the highly interconnected transactions to diversify risk, the banks lost trust in each other to actually repay or settle within the normal course of business. Effectively, a liquidity crunch, driven in part by restructuring assets on the balance sheets in response to mark-the-market asset prices. It took some time for legislators to agree. From just these two cases, who actually discovers that 'we have a problem', does not really matter, it is the agreement between government and the private sector that there is a problem is the turning point.

The next issue to manage is the government's debt limit in the context of bailouts. We assume that governments cannot both bailout the private sector and default on its own debt, however desirable that may be for some ideologies. Once government establishes the level of bailout funds $\overline{s_t^T}$ then is is able calculate the required level of debt to fund the bailout though tradables government budget constraint:

$$d_{t+1}^G = \frac{1}{q_t^G}\left[g_t^T + \frac{s^T}{\psi_t} + I_t^{H*}\overline{s_t^T} + \overline{d_t^G} - \frac{\left(\tau^c c_t^T + \tau_t^y \widetilde{y}^T\right)}{\psi_t}\right] \tag{6.5}$$

with the debt revenue in the current period being qd^G_{t+1}. In the foundation scenario we demonstrate that the government has a natural debt limit d^G_{ndl} that is at the peak of the debt supply curve. Moreover, government cannot exceed the debt limit therefore, the debt constraint:

$$d^G_{ndl} \geq \frac{1}{q^G_t}\left[g^T_t + \frac{s^T}{\psi_t} + I^{H*}_t\overline{s^T_t} + \overline{d^G_t} - \frac{\left(\tau^c c^T_t + \tau^y_t \widetilde{y}^T\right)}{\psi_t}\right] \tag{6.6}$$

generating the possibility that the government does not have the resources to bail out the household. This creates the situation where government may not necessarily default, however, it cannot prevent he household defaulting. Alternatively, when the household defaults, the government does not receive sufficient revenues to fund a primary surplus that then drives the government debt over the tipping point as we have already seen in Chapter 4 and Chapter 5.

If the government survives and bails out the private sector, then this intervention is likely to incur considerably higher levels of public debt that has an effect on the fiscal rule parameter $\psi_{t+1}$and drive the government to implement measures to recover post crisis. One outcome may be austerity measures until public debt falls to a sustainable level and the speed of implementation is reliant on the persistence parameter ρ_ψ. If the government defaults, then it may be the imposition of sanctions on the economy and with the exclusion from receiving foreign investor funds similar to that of the household. The government's probability of returning to good standing with probability θ^G. For simplicity in the the modelling here we assume that government returns to good standing in the next period model, we consider the situation where the government is able to access foreign investment in the next period. One could question this assumption, as normally there is a period of exclusion. However, countries such as Argentina, Brazil and many of the Asian crises countries, governments were able to access foreign investors funds almost immediately.

An alternative two other settings is that the government and/or foreign investors set a covenant, that is a debt limit below the d^G_{ndl} above which the government is not allowed to intervene in the private sector. Alternatively, the government, as a form of self and national protection, may set a level that, if debt is above that level then it is necessary for it to bailout the private sector to ensure that the sanctions do not cause a runaway government debt problem. Hence government protects its revenue stream and the household at the same time. the cut off level is a point where debt below can be serviced by the revenue from taxation. We refer to this target level as d^G_{gs}.

The implementation of $\overline{s^T_t}$in the simulation is by increasing $y^T_t$by the the gross of tax payment $\frac{\overline{s^T_t}}{1-\tau^Y_t}$ for the calculation consumption debt payments and default status. This simplifies the implementation and the net effect in increasing income for the household simulates the normal way that bailouts occur.

6.2.3 Scenarios

These scenarios use the foundation scenario as the basis only varying the strategy. A discussion on the theoretical background, its composition and the foundation scenario is in Chapter 3. We consider two sets of comparisons of scenarios.

The first set is to compare the foundation scenario (with no bailout) with one modification, namely bailout if the household is going to default. We should observe that the default rate for households decreases substantially; however, it is questionable if this reflects into the government default rate. Therefore, by changing one factor of the model we can observe the effect on the pathways during a crisis for different crises classifications.

1. **ALB** - Always Bailout: The Foundation Scenario with the addition of bailouts. Bailout always occurs if there is sufficient availability of funds to bail out the household.
2. **NOB** - Never Bailout: This is the benchmark Foundation Scenario, no bailout under any circumstances.

The second comparison is to set an public debt arbitrary limit that we will call d^{gs}that the government chooses. An example of this is the fiscal budgetary constraint on public debt in the Eurozone of 60% of debt/GDP and a budget deficit of greater than 3% Commission (2015). Therefore, if we set that governments can only bailout the private sector below d^{gs} limit then depending on the state of public debt, how this rule affects the path of a crisis. As the average level of public debt with the foundation model is somewhat lower than the Eurozone limit, however we set the limit at 60%. An alternative specification is that of government only bails out above d^{gs}. This seems somewhat counter-intuitive, however, lets look at the logic that could parallel the gambler's curse. If a government is in a situation that it knows that a private debt crisis will likely end up with a a public debt crisis through the implementation of sanctions will reduce government revenue, hence create deficits to the extent that it pushes public debt over critical point. Although this scenario would be quite unusual, we include it for completeness. On top of the first comparison we add:

1. **ASB** - Only bailout when debt is above a set limit- This is the Foundation Scenario, with bailouts only occur when public debt is above 60% of long run GDP - this is a form of gambler's ruin scenario.
2. **BSB** - Only bailout when debt is below a set limit - Again, the Foundation Scenario, bailouts only occur when public debt is below 60% of long run GDP. This is the EU fiscal responsibility scenario.

6.3 Simulation Results

6.3.1 Frequency Comparison Between Bailout and No Bailout

These two policy extremes, that is bailing out the household or not does not necessarily increase the frequency of event sequences, however by it does change the event sequences from

refusing bailout to attempting bailout as we illustrate in Table 6.2. The two scenarios share the same foundation model parameters and structure, therefore any difference is due to the change from never bailing out to bailing out. First we note that although the government is funding bailouts though public debt, this makes very little difference in government defaulting **GDEFA** sequences. Note that sequences with **BAILx** start with a successful bailout event **BAILx** then if successful classified as **BAILS**, if the sequence ends in a default then is counts in **BAILF. BFHDA** sequences are where the government is debt constrained at the time of the crisis and this would also be the same as some ending of a **BAILF** sequence, that is the net result government is unable to stabilise the economy by bailing out the household. As to stability of the economy, bailing out does not seem to cause any more instability over the economy with less than about 1% change in the total number of defaults. So, if bailing out gives better outcomes for the household and does not induce greater instability then we can infer that it is a preferable policy.

Event	Description	Always Bailout	Never Bailout
ALLxx	All event sequences	**28034**	**27734**
BAILA	All bailout attempts	**21034**	**0**
BAILS	All successful bailouts	**19923**	**0**
BAILF	All bailouts that eventually failed	**1111**	**0**
BFHDA	Could not bail out, household defaults	**123**	**0**
GDEFA	Government default	**6877**	**6638**
HDNBA	No bailout, household defaults	**0**	**21096**

Table 6.2: Summary of the Number of Event Sequences by summary (in bold) and sequence classifications. Note that Any bailout sequence that starts with a bailout (BAILx) and ends with a failure counts towards BAILF. Any sequence that bailout failed, due to debt level being too high and government would default immediately, starts with BFHDx. In no bailout, household defaults as a result is event HDNBx.

We observe in the limiting factor is the number of times the government uses debt to bailout the household as we illustrate in 6.1. Although failure represents less than 7% of the total bailout attempts (that is **BAILA** plus **BFHDA** in table 6.2). With our introductory analysis, this leans us toward the view that governments should always attempt bailing out the private sector. Nevertheless, there might be a limitation on the number of times that implies debt limit has an effect with increasing number of failures the longer that the bailout continues. We therefore contrast this result with the consideration an arbitrary debt limit constraint to bail out later in this chapter.

Next to consider is the the periodicity of crisis for each scenario. We illustrate the different periodicities between event sequences in Figure 6.2a for always bailing out and Figure 6.2b for

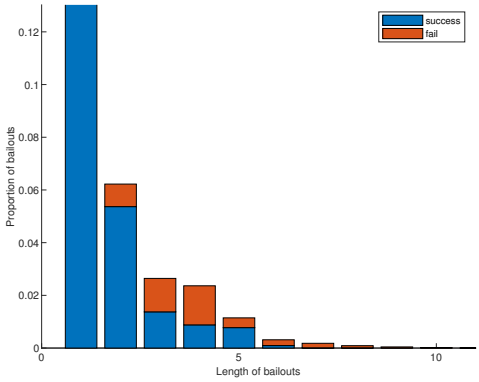
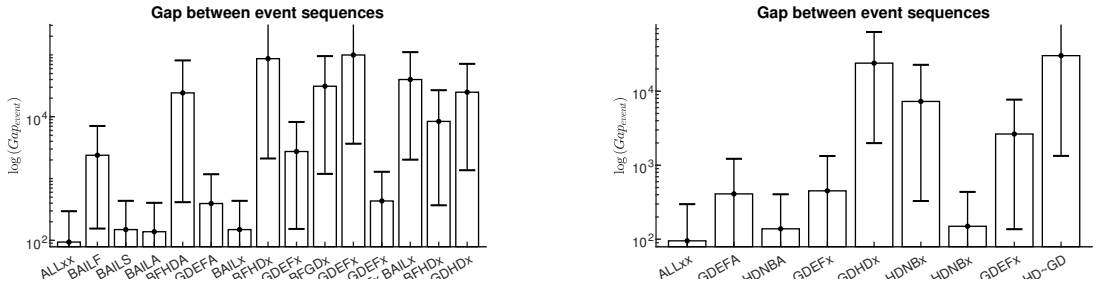


Figure 6.1: (**ALB**) Always Bail out - Distribution how many periods bailing out either before success (Blue) or eventual failure (brown). Note that column 1 represents 85% of the bailouts and is cut off to illustrate the longer sequences.

never bail out scenarios. We define the period between events as the difference in period count between the start of a new event and the end of the last event sequence. The **ALLxx** represents all event sequences, regardless of classification. We observe that the average periodicity between event sequences is approximately 80 periods, household defaults/bailouts approximately105 periods and government defaults are rare at about 750 periods. We find that between bailout and no bailout scenarios there is little difference in the frequency or periodicity of event sequences.



(a) (ALB) - Always bail out

(b) (NOB) - Never Bail out

Figure 6.2: The elapsed time between events of the same type. This compares bailing out against not bailing out.

From our introductory analysis, the bailing out the household has a benefit its income is not attenuated by default sanctions, the foreign investor, as they do not loose their capital and to the government maintains tax revenues without minimally impacting the frequency of default. Furthermore, only if the household requires bailing out more than once in a sequences is there the possibility of failure. We conclude that governments should bailout if they can afford to do so, even when the debt is not in their own currency. Furthermore, the model supports the view that the infrequent nature of crisis We test in the second part an arbitrary debt constraint and the effects on bailout.

6.3.2 Pathway Comparison Between Bailout and No Bailout

We illustrate the results from the simulations for Always Bail out Figure 6.3a and never bail out Figure 6.3bas time paths summarising multiple event sequences as we discuss in Chapter 3 and Chapter 4. The crisis point is $t = 0$ and we record 5 periods before and 15 periods after the crisis inducing event. A successful bailout is a crisis event as much as failing to bailout or public debt default. Therefore the defining event is the first event in the sequence. As expected, the time path for a public debt default (**GDEFA**) are the same for always and never bailout as we do not change any other parameter or setting in the two scenarios.

Our interest is in sequence classifications bailout (**BAILS**) in Figure 6.3a and Household default no bailout (**HDNBA**). Note that $\widetilde{y}^T$for the bailout has a much less sharper dip than that of a no bailout as the implementation of sanctions on household default. The effects of a bailout is a reduction in private debt d^H to sustainable levels by the addition of the bailout $\overline{s}$ that might be followed by a smaller bailout and increase in public debt d^Greflects the deficits Γ^G from the bailout outflows. Consumption suffers a short period dip as does the labour wage income wh. As wages are flexible, the lack of demand drives prices down to counter the effects of wage decline. The net effect on the household is a temporary quick V shaped recession that quickly recovers, however not quite to the same levels. One key aspect of bailout is that it produces a much more stable economy that recovers quickly.

Looking at the alternative no bailout where the government is not as benevolent as the bailout scenario. No Bailout (6.3b) consumption similarly troughs, then peaks then troughs again to a lower level of consumption as sanctions bite into the tradable income stream. We observe the same effect in labour wage wh with prices adjusting accordingly, therefore domestic output and consumption remain flat with a long tail. The main issue is that when the government does not bail out, the household defaults on private debt that goes to zero. For the government, the attenuation on tradable income and consumption directly affects tax revenues, therefore the tradable primary surplus $\Gamma^G$for much longer than if the government had stepped in and bailed out the household. Although not bailing out does not have the same sharp increase in primary deficit, this longer period of deficits has the net same impact on public debt. A counter-intuitive aspect is that bailing out that actually leaves the government better off than not bailing out.

Both bailout and no bailout scenarios have a dip in income and tradable consumption and domestic income, however no-bailout has a immediate bounce back then a fall as the default on debt changes the dynamic of the household. Household devotes all income to consumption, however the imposition of sanctions limits the recovery. This creates a primary deficit that exists for much longer than the bailout scenario leading to increasing public debt and a government response to increase tax rates and decrease tradable social transfers. Increasing the burden on the household during a recovery slows the recovery and the economy remains weak and unstable. In contrast, bailout, although there is a significant impact to the primary deficit, the household recovery is quicker and more stable, making it more resilient. Furthermore, the government tax revenues recover quickly putting the government back into a primary surplus without the necessity of raising taxes to the same extent.

What seems on the face of it to be a non-interventionist Austrian School ideology actually

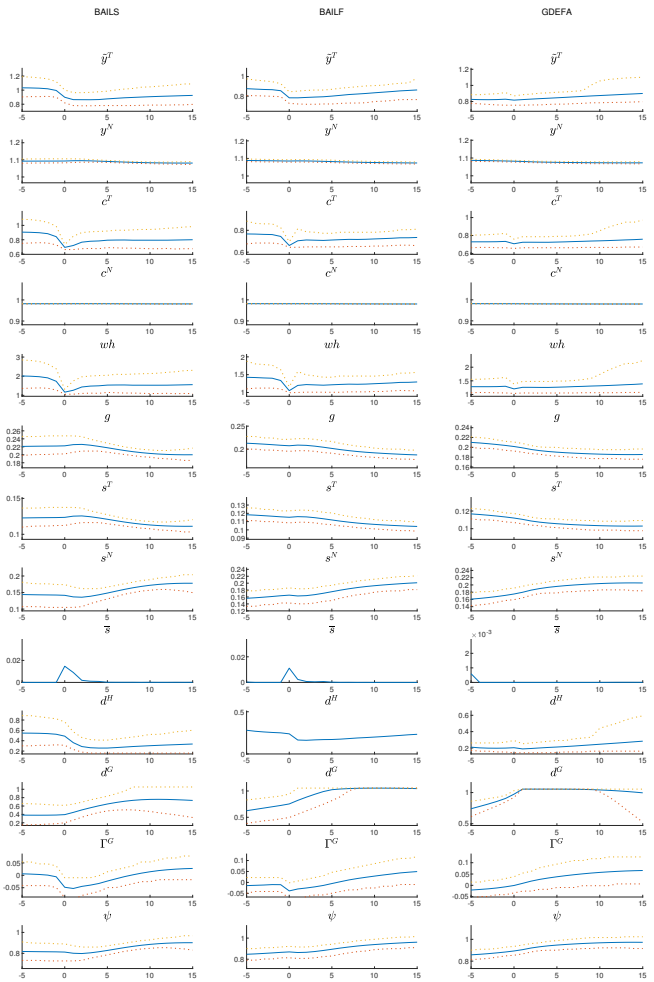
makes the economy behave more poorly than bailing out the household and as a consequence protecting government revenues and the foreign investor. we clearly show that the non-interventionist strategy is far worse for all the economic actors in the economy than a more Keynesian oriented strategy of bailing out the household. We have already shown in our fiscal policy rule analysis that more benevolent government policies work favourably for the household with only a small increase in defaults by the government. Later we will look at a combination of bailing out and a more benevolent fiscal policy setting than the foundation scenario.

Finally, if we consider the situation where government wants to bail out the household, however debt levels prevent to from doing so (**BAILF** in Figure 6.3a). The sequence path for a failed bailout is that government successfully bails out the household, however, repeated bailouts drain the governments resources, namely public debt, to such levels that it cannot bail out or the government defaults in the next period. Examples include a sequence such as **BAILx**, **BAILx.BFHDx** (bailout failed, household defaults) or the most frequent failure sequence is government then household **BAILx.GDEFx**. What this implies is that the government's limited resources when government debt is denominated in a foreign currency causes a default. Therefore if we set a lower limit to debt, this should occur more frequently as we discuss below. Looking at failed bailout sequences (**BAILF**) and comparing them with no bailout household defaults (**HDNBA** in Figure 6.3b) we can see that the initial successful bailout provides relief for the household and prevents the instability that we observe even though a default event occurs during the sequence. Thus bailout creates stability over that of a no bailout strategy by government. Note that the no bailout also can cause the government to default in the next period at a similar frequency to failed bailout. This further reinforces the the view that the government attempting to bail out the household is preferable to that of not doing so.

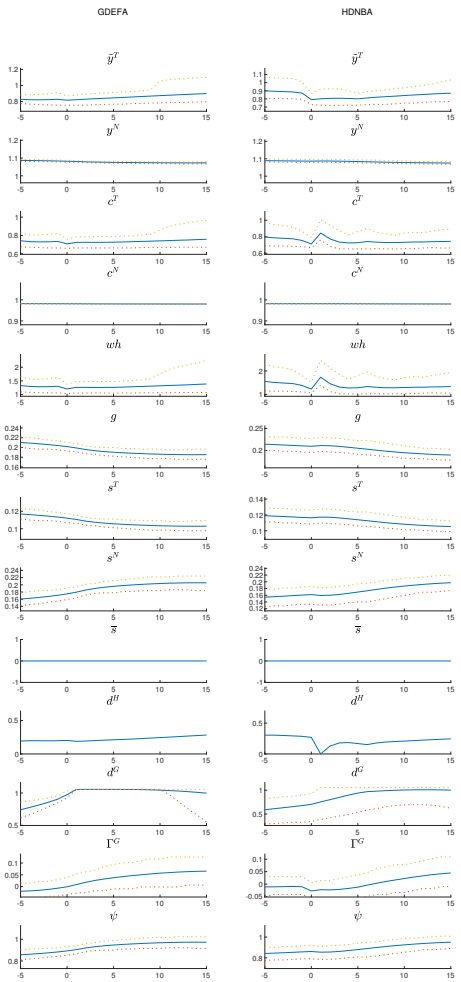
6.3.3 Public Debt Limit on Bailout in Comparison with Never and Always bailout

The next consideration is setting some arbitrary limit to the level of debt that constraints the government in bailing out the household. The example we explain above is that of the EU fiscal responsibility pact that constrains governments to 60% debt/GDP ratio. In our setting, we introduce a finite limit of 60% of the long run tradable GDP although many analysts take the current GDP. As the design of the model is that a falling tradable income generates adverse conditions in the household and government. A falling GDP would naturally increase the debt to GDP ratio accelerating the speed to a crisis. Using a long run GDP provides a stable basis to conduct the analysis of a different pathways that a 60% debt/GDP limit would show. We show a summary of the frequency of sequence in Table 6.4. The left two columns are a repetition of the above analysis; the right two are where we consider an arbitrary debt level; second from right is the above 60% gamblers ruin scenario, the right most column (Below 60%) represents the current EU fiscal responsibility pact.

As before, we consider the periodicity between events sequences of the same classification and all event sequences classifications in Figure 6.4a and Figure 6.4b for the two additional



(a) Comparison of events successful bailout (BAILS), failed bailout (BAILF) and Public debt default (GDEFA) for Always Bailout scenario



(b) Comparison of events government (GDEFA) and household default (HDNBA) for Never Bailout scenario

Figure 6.3: (**ALB**) Always Bailout and (**NOB**) never bailout summary event sequence comparison

scenarios. We note little change in the overall periodicity or overall frequency, therefore the effect is just changes the action by the government on bailing out or not. If the policy of setting an upper public debt limit (**BSB**) actually prevents government default, that is does the EU and IMF policy actually achieve its objective of fiscal responsibility. Note that as we have already demonstrated there is a significant cost to the household and the foreign investor if the household does default.

We note from our simulations that we do not see any change in the public debt defaulting rate (**GDEFA** is the lowest in this comparison) and that a very small number (427) of bailout failures result in the debt limit being reached (**BAILx.HDGTx**). As the policy does not seem to prevent defaulting by the government and in only very limit circumstances does bailing out the household by the government result in crossing the debt limit then it brings into question the value of the policy. Moreover, defaulting has significant negative implications for all, including the government.

This brings into question the economic value of such a rule when it affects the ability of gov-

Bailout	Always (ALB)	Never (NOB)	Above 60% (ASB)	Below 60% (BSB)
ALLxx	**28034**	**27734**	**27860**	**27896**
BAILA	**21034**	**0**	**3499**	**17687**
BAILS	19923	0	2530	17396
BAILF	**1111**	**0**	**969**	**291**
GDEFA	**6877**	**6638**	**6788**	**6722**
HDGTA	**0**	**0**	**0**	**3487**
HDLTA	**0**	**0**	**17444**	**0**
HDNBA	**0**	**21096**	**0**	**0**

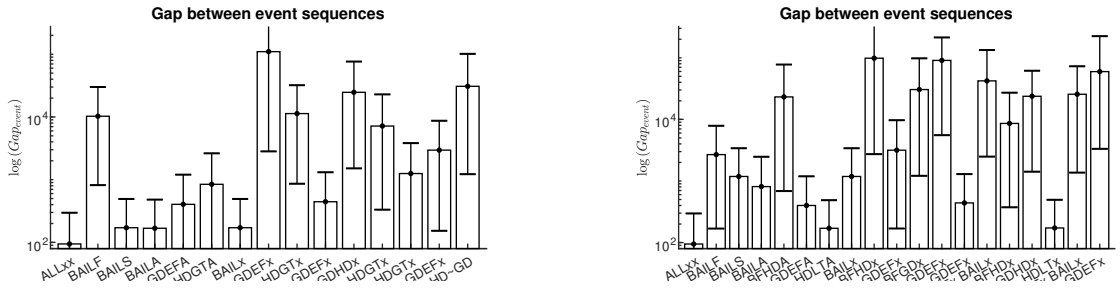
Table 6.4: Note that Any bailout sequence that starts with a bailout (**BAILx**) and ends with a failure counts towards **BAILF**. The four columns are Always bailout the household subject to breaching debt limit (as above), Never bail out (as above), bail out if public debt is above 60% and bail out if public debt is below 60%.

ernment to bail out. Part of the **MMM** policy rule settings tends to keep public debt low. If a policy setting was to raise the level of debt or there is a lower limit then all it would trigger more situations where government refuses bailout, increasing the impact on the household. Although such a limit may have merit as a target during normal times, it has negative impacts in crises the economy, foreign investors and particularly on households that the government is there to protect.

The alternative is the bailout only when debt is high. This raises the question, such a strategy would be the worst of both worlds, that is punishing to the household when the government has fiscal space in public debt to bail out the household, the attempt to protect the government from the consequences of sanctions affecting tax revenues. Again, there is little difference in the periodicity or frequency of crisis other than it changes driven by the debt limit Table 6.4. Such a strategy has little effect on the public debt default (**GDEFA**) or bailing out and then defaulting **(BAILx.GDEFx**). Nevertheless, it does have serious implications for the household when government operates such a strategy. The household defaults as a result of the constraint (**HDLTA**) climb making it similar to the effects of not bailing out on the household and the economy. Although the government is able to survive a private debt crisis even with reducing the tax revenue from the effects of sanctions, not bailing out under these circumstances detrimental effects and the political landscape that it is likely to fall on is probability going to cause civil unrest.

6.3.4 Time-path Comparison Between Different Event Classifications

Next is to compare the time paths for never bail out, our worst case with bailing out above or below the policy debt limit. Starting with a comparison between never bail out with bailout if below the debt limit, the EU fiscal responsibility rule that we illustrate in Figure 6.5. We



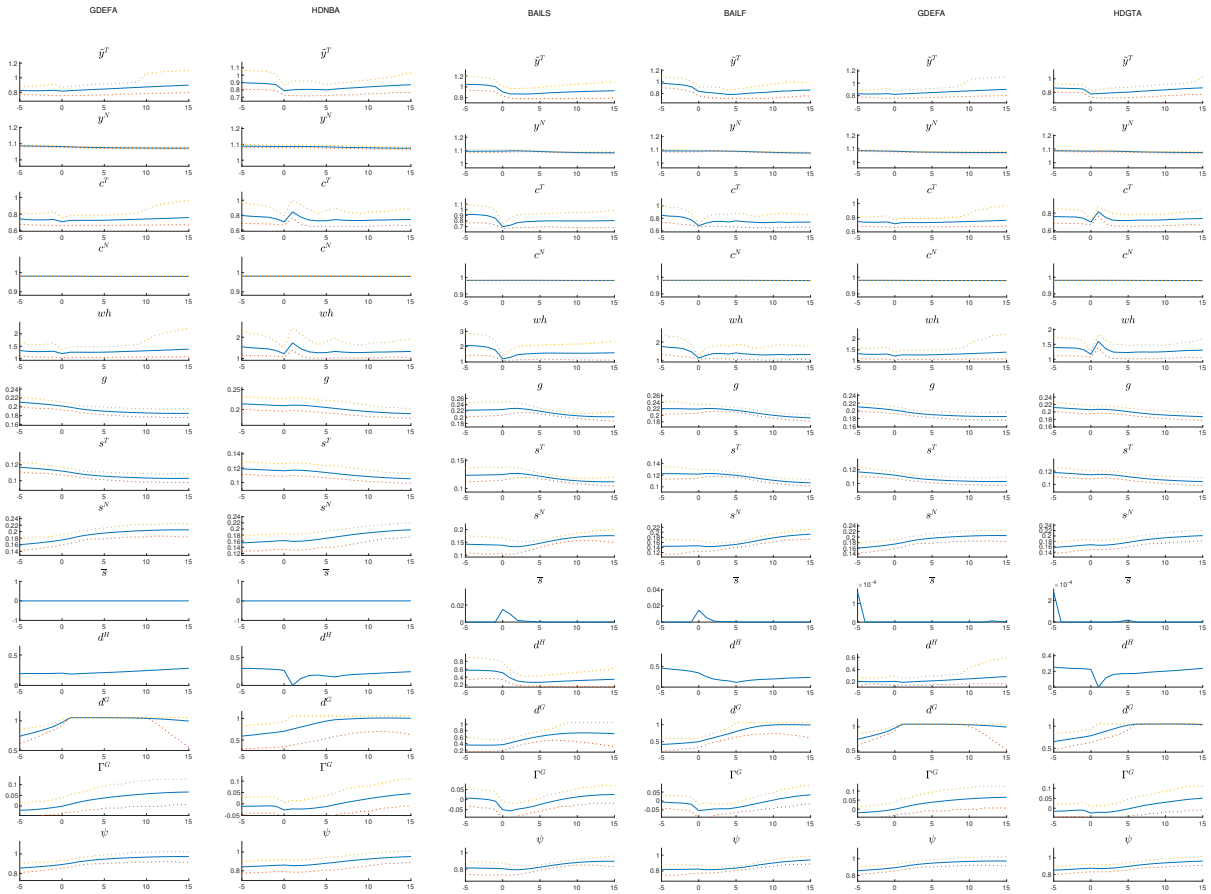
(a) Above 60% (ASB) (b) Below 60% (BSB)

Figure 6.4: The elapsed time between events of the same type. This compares bailing out above 60% and below 60%

note that, as before, there is no difference in the paths of public default (**GDEFA**). An interesting point is that when the government does not bailout when debt is above debt limit and household defaults (**HDGTA**) follows a similar time path as the never bailout (**HDNBA**). Some important differences however, in the government debt that are not unexpected. That is in the sequence **HDGTA**, public debt hits its debt limit with a greater frequency and earlier after the crisis commences. As, effectively, the bailout limit policy filters out all of the low debt circumstances with a bailout; when the government is above that limit then it likely that the sanctions will cause a default as tax revenues drop and a primary deficit occurs $\Gamma^G < 0$ at the worst point making a perfect storm in a crisis. Although not every refusal results in public default, approximately $1/3$ do indicating that the policy is counter-productive to the government in protecting itself from a crisis.

The alternative policy setting is that of only bailing out to prevent a crisis that will put public debt at risk of default. This somewhat self interested has some elements of a gambler's ruin, however it does split the bailout scenarios into two classes when considering the fiscal responsibility pacts above. We do not take into account any foresight by foreign investors that would lead them to recalculate the risk beyond the next period, however, we can show that bailing out even when government debt is in excess of the fiscal limit has merit as it does not cause additional government defaults, whilst protecting the household. We illustrate these points in Figure 6.6 by observing the time paths of bailout (BAILS) where there is little change in the frequency of events and the time paths demonstrate better outcomes for the household. The arbitrary cut off point causes households to default as the alternative to bailout as we show in Figure 6.6b event sequence household default, **HDLTA**. Note that not bailing out causes a rippling effect in both household consumption c^T and government primary surplus Γ^Gthat reflects into the domestic economy in wage income wh.

One aspect is that government not bailing out is in someway a strategy for not increasing its level of government debt, however the rippling of a primary deficit has a similar effect as the

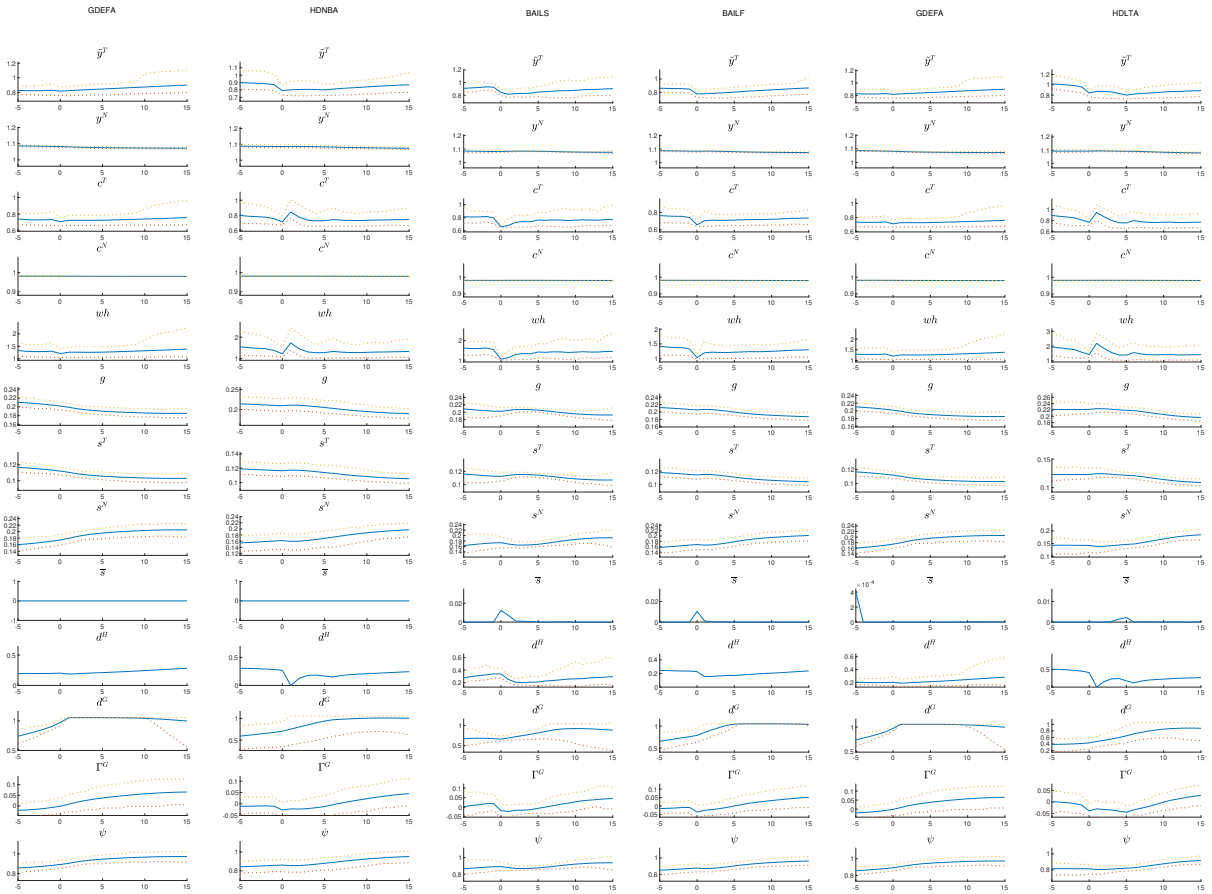


(a) No Bailout (b) Bailout only if below 60%

Figure 6.5: comparison between No Bailout and Bail out if below

government bailing out the household (see Figure 6.3a column **BAILS**), so what seems on the face of it to be a mechanism to protect the government does not really achieve that objective. The reverse in actuality with the household being negatively impacted by government failure to respond leading to its own income deficit. We can only conclude that this self interested strategy is at best, short sighted. The whole economy and foreign investors would be better served if the government bailed out the household.

Another way of looking at this particular problem is if the foreign investor had influence over the government. One could logically argue that high levels of government debt, then the imposition of sanctions on the economy would cause the government to default with the household. The foreign investor might perceive that such a crisis is far worse than bailing out the household in high debt situations and taking a risk that government ends up defaulting. However, at low levels of debt, the foreign investor might not be so included and not extend credit to the government to fund such a campaign of bailouts. This would be an example of the old adage of good money chasing bad. We demonstrate that this is also shortsighted, it would be better for the government to bailout the household and take the increase in debt, albeit only marginally greater than the situation where it does not bail out. The issue for the foreign investor is are they taking a gambler's ruin strategy or are they actually protecting their investment. We conjecture that more often than not, protecting their investment by allowing the government to



(a) No Bailout (b) Bailout above the public debt limit.

Figure 6.6: comparison between No bailout and bail out if above limit

bail out the household.

6.4 Conclusion

Our modelling shows that the never bailout policy (foundation scenario) is significantly the worst option for the economy when comparing with any bailing out strategy. Always bailing out has little impact on the frequency or periodicity of crises including government lead public debt crises. We include the debt limited strategy to replicate the EU/ECB fiscal responsibility pact. We show that such a pact is actually worse for the country that it is being applied to that just bailing out the household and then dealing with any fallout from public debt. One aspect of this model is that it bails out the *household* and not the bank or foreign investor. However, the foreign investor does gain out of the bailout in that they do not suffer the losses from household default. This implies that the foreign investor would be best to work with the government on a private sector rescue package and fund the government debt, even if it has to accept some haircut at a later stage. If this is the case, the it becomes a political decision on the role of government as a backstop for the private sector. We discuss the implications of bailing out or not households and firms in the context of the 1929 and 2008 crisis with some reflection on the 2020 crisis as it unfolds.

We note that the focus of the 1933 New Deal package in the US was largely about improving the household by work schemes of national and local importance, restructuring core elements of the economy and improving the support to the general workforce. These were largely demand side Keynesian style expansionary policies. This is in contrast to the the 2008 bailout packages that largely focused on preventing financial system collapse and then trying to create sufficient supply of credit with very little real structural change and future relaxation of workforce protections. This was a largely supply side bailout. 2010 saw some southern EU countries and the UK enter a period of austerity to varying degrees in an attempt to address the so called burgeoning public debt crises, without addressing the underlying socio-structural-economic issues. The idea that public debt is a problem comes largely from Academic economic actors of note over an extended period from the 1950's onwards. The more right wing political parties became guardians of these fiscally conservative policies and the free market ideology. Furthermore, this school aligned with the Austrian/Heyakian ideologies on the role of government minimalism.

The evidence from prior crises and this model is that any bailout must focus on the household rather than firms and financial institutions. If the damage to the household can be limited, then this will flow though the economy to banks, with lower default rates and firms with demand for the output. An important point is that from the 2008 crisis, banks may need to be recapitalised, however there must be an onus on the government to ensure that banks never put the economy in that position again.

Chapter 7

Public Debt Management In a Crisis

7.1 Introduction

In this chapter we broaden the government's strategies from a fiscal policy and bailout intervention to that of how it manages public debt in a crisis. A core assumption of much of the current research is that government defaults on all of the public debt similar to that we have in the private sector. We contend that this assumption does not reflect the what happens during a crisis and we uniquely create some alternative scenarios to cover other possibilities. It is rare that a public debt default is on all of the debt, rather it is on some level that either can fund though issuing more debt and primary surpluses or some agreed level.

Under the Paris Club, there is a process for negotiating a settlement between countries that are in default and the investors. Normally, triggering this process is either a default event by the government on public debt or there being the threat of public debt default. Most defaulting or events leading up to default are strategically or tactically made at the time rather than a hard and fast ex-ante policy setting (Haldane et al., 2003; Yue, 2010). The mere threat of default tends to bring both debtor and creditor into negotiation that restructures the payment schedules and principle of the debt. We observe this behaviour during corporate and sovereign debt negotiation. It is neither in the interests of the government nor the investor for a full default to occur. The government and country loose though exclusion from credit and restrictions on trade finance and the foreign investor looses the asset principle. In some cases the loss of the asset and write down causes serious issues for the investor.

In Chapter 1 and Chapter 2, we have already discussed the historical, socio-political and empirical backgrounds to these strategies that we will briefly expand on here. Our focus is on countries that have some restriction on theory monetary control and denomination of debt. These restrictions may be by treaty, pegging or banding a currency, government policy or situations where a significant part of public debt is denominated in foreign currency (Fullbrook and Morgan, 2020). A government that has full monetary control over its currency and it is acceptance by foreign investors that its domestic currency denominated public debt has flexibility in managing its debt situation. There is no reason for it to ever default on its debt, freeing the government to use fiscal policy as a mechanism to regulate the economy (Connors

and Mitchell, 2017; Fullbrook and Morgan, 2020). The governments only limitations are that of demand in excess of supply and that if government uses excessively expends by importing or induces such behaviours. Moreover, if foreign investors are the principle source of debt income, then exchange rate depreciation risk is likely to play a role in quantity and interest rate expectations. Large sovereign nations with a safe currency and political stability is likely to always be able to fund its debt; however a smaller currency may experience problems if the international market for credit and currency perceive an 'excessively' creating money for non-productive purposes or importing (Mankiw, 2020). One issue that is largely missed by the classical schools in economics is that commercial banks create most of the money in the economy and that money creation or destruction derives from banker's preferences for profit and risk within a regulatory framework (McLeay, Radia and Thomas, 2014; Faure, 2020). We contend that for 'trusted' nations, with what appears to be well regulated regimes, are likely have a greater degree of flexibility over those with a 'developing' status where institutions are not so mature.

One aspect is the changing role of taxation for sovereign currency governments (Baker and Murphy, 2020). Traditionally, though the classical lens, taxation is seen to fund government expenditures and debt, particularly the case with debt that is in a foreign currency. Therefore, in our modelling, this is the important mechanism for preventing public debt. However, taxation holds a unique aspect in that it can be highly targeted and redistributive when compared to other tools such as interest rate control. This redistributive and regulating effect on the economy has fallen out of favour for the more monetarist strategies for regulating the economy over the past 30 years. Now, it might be more difficult in a country that has not the freedom aspects to government debt that we show above, nevertheless, it can still operate with a combination of fiscal and monetary policy. The government is only limited by the productive capacity of the economy and that excess effective demand in any particular sector creates Inflation in that sector. Therefore the government can use taxation and social transfers to ensure that a balanced economy across all sectors and strata of society. Core to this philosophy is the ability to make and destroy money by the government (both fiscal and monetary), domestic banks and foreign banks with a domestic license (McLeay, Radia and Thomas, 2014; Kelton, 2020). This is in stark contrast to that of neoclassic economics, where all governments our bound by a inter-temporal budget constraint as we specify in the foundation model. Therefore we paint a worst case constrained view of government policy and strategy regarding default.

There are two aspects to consider on the quantity of defaulting debt when a crisis occurs. First is that not all of the debt is repaid at the same time, a normative assumption in classical economic modelling. Generally, there is a schedule of debt terms, quantities and effective interest rates. Government is only obliged to repay what falls due which may be a combination of interest and principle. It is common that government only partially default on debt, that is they default on what is due. Sometimes this is strategic, that is they might only default on interest or some of the principle, sometimes this is due to the inability to sell sufficient debt at a price to fund repayment or some combination. The next effect is that only a small proportion of the debt is defaulted on, the rest continuing to be serviced. Second, a core difference between public debt and private debt is enforceability by the court system or internationally. An organisation may

be forced into into administration and assets distributed under a judicial process; however, the same rules do not apply to nations (Bulow and Rogoff, 1986). Nation states cannot be forced into administration, taken over or forced redistributing of their assets. Therefore, the power of the creditor is limited to the imposition of sanctions and likely to force all parties into negotiations.

Normative prescription of commercial debt is for creditors and debtors to enter into negotiations rather than force administration. The creditor is more likely to negotiate to limit losses and possibility restructure the funding of the organisation rather than take the risk of loosing a significant part of the principle in a liquidation. Hence, the formation of the Paris club over 60 years ago to assist creditors and debtors to negotiate debt restructuring (Cheng, Díaz-Cassou and Erce, 2018). Over time this organisation has morphed from one principally aiding to recover debt for creditors to one that has an orientation towards developing country improvement, reducing poverty and inequality. These debt renegotiations tend to have a lasting effect on the productive sector of the economy, in our modelling, the domestic sector. Repeated defaulting by the government where the haircut initially was insufficient, keeps the risk premium high and a tight fiscal policy (Arteta and Hale, 2008). A government may enter into debt restructuring before an actual crisis event occurs . The crisis event becomes the point at which the restructuring occurs and the implementation of a limited haircut.

Most defaulting models have some form of exclusion and sanctions as summarised in Na et al. (2014) following the pattern that default is on the total level of debt. The foundation scenario provides the first alternative to default on all debt, namely considers haircuts to what the government can immediately repay when it has insufficient funds to repay debt (Mount and Zumel, 2016). That is, it will repay to the foreign investor as much as it can obtain from sale of new debt and the primary surplus. However, the nature of debt repayment and the near exponential increases in interest rates to cover risk means that the government is more likely to default in the next period as well. Only when debt service costs accelerate beyond the capacity of the economy to generate foreign funds does it contemplate default. We show in the foundation scenario public debt default sequences that run for many periods. This is undesirable to both the country and the foreign investor (Bulow and Rogoff, 1986). Repeated haircuts may not provide the optimal outcome for ether party Furthermore, the imposition of sanctions on the economy impacts the household's ability to repay debt, and their consumption. The rippling effect though the economy, as we show in the foundation model can be significant creating an almost second subsistence equilibrium akin to that found in the General Theory (Keynes, 1936). Therefore, continuing with haircutting only sufficiently to get the government out of the immediate crisis is unlikely to be realistic (Arteta and Hale, 2008).

In the following sections, we consider the effects of these different defaulting strategies by the government comparing them with the foundation scenario, default to the maximum level of debt that can be funded by the primary surplus and acquisition of debt. We consider some alternative strategies that the government may take including defaulting on almost all of the debt, a level that makes debt affordable using the current level of primary surplus and finally an arbitrary level of debt that may be agreed by Paris negotiations.

7.2 Foundation Model and Scenario Extensions

The set up to of the additional scenarios is founded on foundation scenario permitting us to compare the relative performance of each of these strategies with a baseline foundation. The only modification to the foundation scenario to generate the debt management strategies as follows:

1. Default to natural debt limit **(HCDL**) - this is the foundation model and scenario strategy that we have already discussed in Chapter 3 in detail.

2. Default to an affordable level of debt (**HCPS**) - this is what one could call a 'sensible' strategy that should ensure that persistent public debt defaults do not occur after the initial event

3. Default to the lowest level of debt (**HCLL**) - this is the worst case strategy for the foreign investor and has potential for use as a threat by the government to force foreign investors not to attempt to implement a high level of debt repayment

4. Default to a nominated level of debt (**HC23**) - This is a arbitrary level of debt post crisis that we intend to model as an agreement between government and foreign investor. By construction this strategy can be set to any level between the lowest level of debt and the natural debt limit.

We apply these strategies to the foundation scenario's mid point point fiscal policy rule (**MMM**), a no bailout policy (**NOB**), a flexible wage environment (**FW**) and an expansionary fiscal ideology (**EXP**). An extension is to combine in the always bail out (**ALB**) strategy that we discuss in Chapter 6 with some form of debt management. One of the main problems with bailing out is the rapid build-up of public debt.

7.2.1 Foundation Model, Recalling the Strategy Public Debt Default to Natural Debt Limit (HCDL)

We need to logically extend the Foundation model mathematics and theories to incorporate the new strategies. We illustrate the implementation of the above strategies in Chapter 4. For completeness, we start by reiterating the core parts of Chapter 3[1] to provide the basic government budget equation to generate a primary surplus Γ^G:

$$d_t^G - q_t^G d_{t+1}^G = \Gamma_t \tag{7.1}$$

therefore, in this model, governments running persistent primary deficits will result in increasing levels of public debt and there be a balanced budget, that is an equilibrium:

[1] We recommend that reviewing the charts in Chapter 3 provides the reader with a baseline to compare the effects of these strategies.

$$\left(1 - q^{G*}\right) d^{G*} = \Gamma^* \tag{7.2}$$

This means that it is necessary for governments to run a primary surplus that is equivalent to the debt service charge by foreign investor. The debt service charge derives from the core of the foundation model here for clarity and by way of introducing the changes for the different defaulting and haircutting strategies. Government repays its debt in full, if the current level of debt is below the effective government debt limit. In any other circumstance, it defaults, formally:

$$I_t^G = \begin{cases} 1 & d_t^G < d_t^{G*} \\ 0 & d_t^G \geq d_t^{G*} \end{cases} \tag{7.3}$$

Where the stochastic debt limit ,$d_t^{G*}$is drawn from a exogenous distribution, $d_t^{G*} \sim D^{G*}$ that is non-linear in that it rapidly rises once the probability of default starts to rise. We express the debt limit cumulative density using a logistic function with two parameters with calibrations from the data. The probability of default, ϕ_t that is the probability of $I_t^G \to 0$ given that the government is not in default, is:

$$\phi_t^G = \Pr\left(d_t^G \geq d_t^{G*}\right) = \frac{\exp\left(\eta_1 + \eta_2 d_t^G\right)}{1 + \exp\left(\eta_1 + \eta_2 d_t^G\right)} \tag{7.4}$$

Any given level of government debt d_t^G, the default probability is ϕ_t that represents the risk premium over the gross international interest rate $1 + r^*$. Hence, the determination of the price of public debt the probability of not defaulting in the next period:

$$q_t^G = \frac{\mathrm{E}_t\left(1\text{-}\phi_{t+1}\right)}{1 + r^*} \tag{7.5}$$

Combining (7.4) with (7.5) provides a price that foreign investors are willing to offer:

$$q_t^G = \frac{\mathrm{E}_t\left[1\text{-}\frac{\exp\left(\eta_1+\eta_2 d_{t+1}^G\right)}{1+\exp\left(\eta_1+\eta_2 d_{t+1}^G\right)}\right]}{1 + r^*} \tag{7.6}$$

The government's demand for debt d_{t+1}^G at the price the foreign investors are willing to offer derives primary surplus (or deficit) and the current level of public debt, hence:

$$d_{t+1}^G \left\{ \frac{\mathrm{E}_t\left[1\text{-}\frac{\exp\left(\eta_1+\eta_2 d_{t+1}^G\right)}{1+\exp\left(\eta_1+\eta_2 d_{t+1}^G\right)}\right]}{1 + r^*} \right\} = d_t^G - \Gamma_t \tag{7.7}$$

and the debt to be repaid at the next period is:

$$d_{t+1}^G = \frac{d_t^G - \Gamma_t}{q_t^G} \tag{7.8}$$

If the required level of debt is greater than the natural debt limit,$d^G_{t+1} \geq d^G_{ndl}$ then the government needs to default on public debt and that will limit the debt repayment $\overline{d^G_t}$:

$$\overline{d^G_t} = \begin{cases} q^G_t d^G_{t+1} + \Gamma^G & d^G_{t+1} < d^G_{ndl} \\ q^G_{ndl} d^G_{ndl} + \Gamma^G & d^G_{t+1} \geq d^G_{ndl} \end{cases} \tag{7.9}$$

Hence, the haircut is:

$$\overline{hc^G_t} = \begin{cases} 0 & d^G_{t+1} < d^G_{ndl} \\ d^G_t - q^G_{ndl} d^G_{ndl} - \Gamma^G & d^G_{t+1} \geq d^G_{ndl} \end{cases} \tag{7.10}$$

alternatively, using the default indicator for government, the government repayment $\overline{d^G_t}$ is the either new debt revenue priced at q^G_t plus any primary surplus or the natural debt limit at price q^G_{ndl} plus any primary surplus:

$$\overline{d^G_t} = \left(1 - I^G_t\right) q^G_{ndl} d^G_{ndl} + I^G_t q^G_t d^G_{t+1} + \Gamma^G \tag{7.11}$$

If in default, then the haircut is the current outstanding public debt stock d^G_t less the revenue from selling new debt at the natural debt limit less any primary surplus thus:

$$\overline{hc^G_{ndl,t}} = \left(1 - I^G_t\right) \left(d^G_t - q^G_{ndl} d^G_{ndl} - \Gamma^G\right) \tag{7.12}$$

7.2.2 Strategy - Default to an Affordable Level of Debt (HCPS)

Haircutting to the debt limit is not necessarily the most effective strategy for either the government or the foreign investor. We observe that this strategy tends to generate a long period of continual defaulting that creates large losses for the foreign investor. More reasonably, if we apply the outcomes from a Paris Club style negotiations where the government and creditors to agree to an affordable level of debt then we are more attuned many real world examples. We use the current primary surplus to determine the affordable level of debt. When the government cannot afford to repay its debt as in $d^G_{t+1} \geq d^G_{ndl}$ then we start at (7.7) and find the level of debt that $d^G_{ald,t}$by solving:

$$d^G_{ald,t+1} \left\{ \frac{\mathrm{E}_t \left[1\text{-}\frac{\exp\left(\eta_1 + \eta_2 d^G_{ald,t+1}\right)}{1+\exp\left(\eta_1 + \eta_2 d^G_{ald,t+1}\right)} \right]}{1 + r^*} \right\} + hc^G_t = d^G_t - \Gamma_t \tag{7.13}$$

where hc^G_t is the haircut necessary to obtain an affordable level of debt. The price of the affordable level of debt by solving the system of equations (7.14) and (7.15):

$$q^G_{ald,t} = \frac{\mathrm{E}_t \left[1\text{-}\frac{\exp\left(\eta_1 + \eta_2 d^G_{ald,t}\right)}{1+\exp\left(\eta_1 + \eta_2 d^G_{ald,t}\right)} \right]}{1 + r^*} \tag{7.14}$$

Where the equilibrium level of debt for a given level of primary surplus is:

$$d^G_{ald,t} = \frac{\Gamma^G_t}{\left(1 - q^G_{ald,t}\right)} \tag{7.15}$$

This then provides for a haircut $hc^G_t$when default occurs.

$$hc^G_t = d^G_t + \Gamma_t - q^G_{ald,t} d^G_{ald,t+1} \tag{7.16}$$

Note that if $\Gamma^G_t \leq 0$ and the the affordable level of debt cannot exceed the natural debt limit by definition$d^G_{ald,t+1} < d^G_{ndl}$then we use the lowest level of public debt and it reverts to the 3rd option below. Combining no default and default conditions together we get:

$$d^G_{ald,t+1} = \begin{cases} \frac{d^G_t - \Gamma^G}{q^G_t} & d^G_{t+1} < d^G_{ndl} \\ \frac{\Gamma^G_t}{\left(1 - q^G_{ald,t}\right)} & \Gamma^G_t > 0,\ d^G_{t+1} \geq d^G_{ndl},\ d^G_{ald,t+1} < d^G_{ndl} \\ d^G_{low} & \Gamma^G_t \leq 0,\ d^G_{t+1} \geq d^G_{ndl} \end{cases} \tag{7.17}$$

Furthermore, government is in default when $I^G_t = 0$:

$$I^G_t = \begin{cases} 1 & d^G_{t+1} < d^G_{ndl} \\ 0 & \Gamma^G_t > 0,\ d^G_{t+1} \geq d^G_{ndl},\ d^G_{ald,t+1} < d^G_{ndl} \\ 0 & \Gamma^G_t \leq 0,\ d^G_{t+1} \geq d^G_{ndl} \end{cases} \tag{7.18}$$

$$I^{GL}_t = \begin{cases} 0 & d^G_{t+1} < d^G_{ndl} \\ 0 & \Gamma^G_t > 0,\ d^G_{t+1} \geq d^G_{ndl},\ d^G_{ald,t+1} < d^G_{ndl} \\ 1 & \Gamma^G_t \leq 0,\ d^G_{t+1} \geq d^G_{ndl} \end{cases} \tag{7.19}$$

Note, if there is a primary deficit, that is $I^{GL}_t < 0$ then we cannot calculate the affordable level of debt and we assume that both the primary deficit and the debt is written off as a haircut. We also assume that in such a crisis with a primary deficit, a clean sheet base level of public debt near zero operates[2].

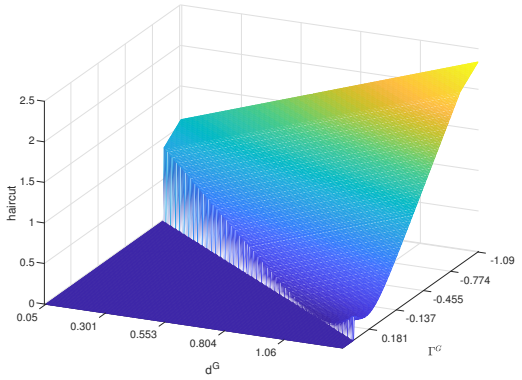
Therefore, the government needs to haircut public debt by:

$$\overline{hc^G_{ald,t}} = \left(1 - I^{GL}_t\right)\left(d^G_t - q^G_{ald,t} d^G_{ald,t+1} + \Gamma^G_t\right) + I^{GL}_t\left(d^G_t - d^G_{low} - \Gamma^G_t\right) \tag{7.20}$$

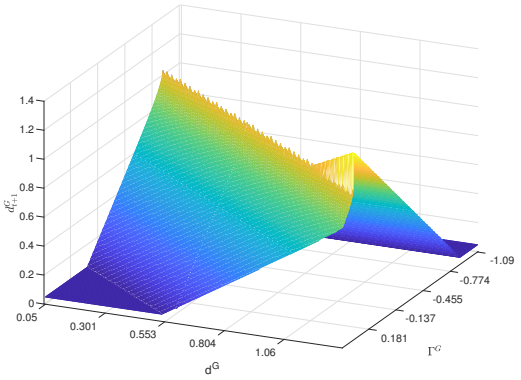
We illustrate graphically, the implementation of this strategy in both the debt transformation and haircuts in Figure 7.1. The affordability has a significant influence on the size of the haircut.

[2]The log function in the fiscal policy rule prevents using zero debt or negative debt, therefore we set to a near zero value to simulate the circumstance were public debt is clean slated however a minimal level still operates in a public debt crisis. Our testing shows that this has little impact of the performance of the model in demonstrating the impacts of such defaulting strategies.

Note the difference between haircut to debt limit and affordable debt level Figure 7.1a. At the line the demarcates between in good standing and default, the haircut to debt limit has a slope from that point, whereas the affordable debt level has an immediate correction, represented by the vertical 'wall' across the current debt and primary surplus plane.



(a) Haircut size given a current level of public debt and primary surplus to determine the haircut that is necessary for the government to be able to re-balance its budget.



(b) Public Debt in the next period, given the current level of debt and primary surplus. Note that as the primary surplus decreases (or goes to a deficit) the level of debt in the next period decreases.

Figure 7.1: **HCPS** - Haircut debt to affordable at current level that the primary surplus indicates

7.2.3 Strategy - Default to the Lowest Level of Debt (HCLL)

Another strategy that a government may adopt is when negotiations fail to reach an agreement. This is a full default that writes off all of the debt[3]. This follows the norm of most classical models. The calculation is similar to that of defaulting to a fixed debt limit with the modification that the target level is the lowest level of debt. Furthermore, the primary surplus becomes irreverential in this case as the haircut is deep and written off as part of the haircutting process. This is the worst outcome for the foreign investor and likely to cause a long period of sanctions. In summary we set the debt and haircut:

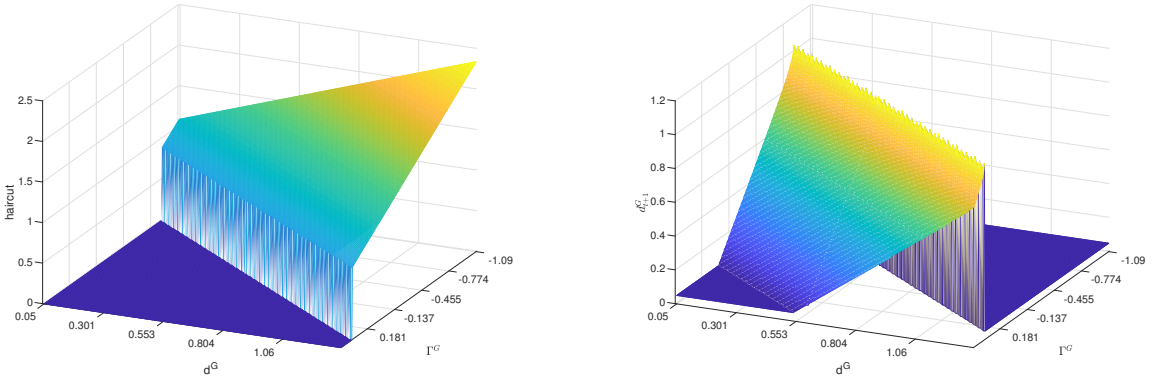
$$\overline{d_t^G} = \begin{cases} q_t^G d_{t+1}^G + \Gamma^G & d_{t+1}^G < d_{ndl}^G \\ d_{low}^G & d_{t+1}^G \geq d_{ndl}^G \end{cases} \tag{7.21}$$

where d_{low}^G is the lowest level of debt. Hence, the haircut is:

$$\overline{hc_t^G} = \begin{cases} 0 & d_{t+1}^G < d_{ndl}^G \\ d_t^G - d_{low}^G - \Gamma^G & d_{t+1}^G \geq d_{ndl}^G \end{cases} \tag{7.22}$$

[3]We set the debt level to the lowest level according to our decision rules. This simulates the worst case for the foreign investor.

This strategy is the threat to the foreign investor to initiate negotiations and come to a settlement. Again we illustrate the public debt state transitions and the haircuts in Figure 7.2. Note that the vertical wall is high and parallel top and bottom indicating the 'reset' nature that this strategy operates. Further the we assume that the debt is not discounted by the sell price q_t^Gas it is near zero level.



(a) Haircut size

(b) Debt In next period

Figure 7.2: **HCLL** - Haircut to lowest level of public debt

7.2.4 Strategy - Default to a Nominated Level of Debt (HC23)

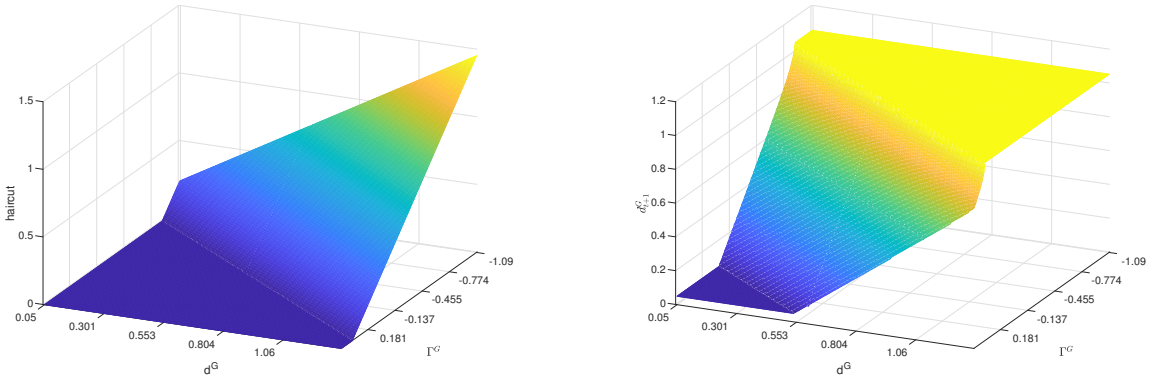
This strategy is somewhat similar to that of hair-cutting to the lowest level of debt (**HCLL**) and it a logical extension. This strategy is likely to be after some period of negotiation between the government and foreign investors. Although government may desire to cut to the lowest level, the threat of exclusion by foreign investors is likely to have a significant impact on both domestic private and public sectors. Likewise, the foreign investor might consider the haircutting to the NDL as a short term strategy as the likelihood of the next period being in default is high. One observes this in the Foundation scenario time paths where haircutting occurs many times after the initial public debt default. This would lead us to some agreement that the affordable level of debt would be the logical conclusion. However, if the government is running a primary deficit then the haircut will be the same as hair-cutting to the lowest level of debt. There is only a narrow band where a primary surplus would give a fair indication of the level of debt the government can sustain. Therefore, the only option is for government and foreign investor to negotiate. We determine that the government would want some 'headroom' in the level of debt and the foreign investor would want to see as much repaid as possible. Arbitrarily we set the negotiated debt level to two thirds of the NDL which is below the point that governments are unlikely to default within a couple of periods. The effect is that the fiscal policy rule response to debt would induce higher tax rates and lower social transfers/government expenditures akin to the austerity measures that IMF and World Bank impose as a matter of course when shoring up a nation's financial position. Nevertheless, we can set the nominated level d_{NL}^G at any level between the NDL $d_{ndl}^G$and near zero d_{low}^G. to simulate a particular circumstance. We assume that the investor forgives interest as a part of the negotiations. The specification:

$$\overline{d_t^G} = \begin{cases} q_t^G d_{t+1}^G + \Gamma^G & d_{t+1}^G < d_{ndl}^G \\ d_{NL}^G & d_{t+1}^G \geq d_{ndl}^G \end{cases} \tag{7.23}$$

Hence, the haircut is:

$$\overline{hc_t^G} = \begin{cases} 0 & d_{t+1}^G < d_{ndl}^G \\ d_t^G - d_{NL}^G - \Gamma^G & d_{t+1}^G \geq d_{ndl}^G \end{cases} \tag{7.24}$$

This strategy is the threat to the foreign investor to initiate negotiations and come to a settlement. Again we illustrate the public debt state transitions and the haircuts in Figure 7.2. Note that the vertical wall is high and parallel top and bottom indicating the 'reset' nature that this strategy operates.



(a) Haircut size

(b) Debt In next period

Figure 7.3: **HC23** - Haircut to 2/3 between debt limit and target debt

7.3 Simulation Results

We run additional simulations for the three new strategies and report them here. All Scenarios are run using the same model and the scenario governs the decision made in the simulation. All simulations use the same seed for the stochastic processes limiting the only variation to the changes imposed by the scenario.

7.3.1 Frequencies and Durations

Our basic summary statistics on the frequency of event sequences for scenarios with a no-bailout Table 7.2 and those with always bail out Table 7.4. An inspection of the event sequence frequencies indicates that defaulting to debt limit (NDL) is the least frequent and somewhat surprising is defaulting to the lowest level being the most frequent. An explanation is that the

event sequence heuristic analyser sets a limit of four periods between one period events (unless in sanctions) to tie them into a sequence. Defaulting to the lowest level might mean that debt recovery path from near zero takes longer than a default to the debt limit. We should observe that government default sequences (**GDEFA**) tend to be shorter with defaulting to the lowest level when comparing with defaulting to the natural debt limit[4].

Event	Default Description	NDL (HCDL)	Afford (HCPS)	Lowest (HCLL)	Target (HC23)
ALLxx	All defaults	27734	30295	36815	32216
GDEFA	All government initiated	6638	7700	12939	9110
GDEFx	Government only	6104	5554	12311	8038
GDEFx.GDHDx	Government followed by household & Government	125	1546	230	390
GDEFx.HDNBx	Government followed by household only	409	600	398	682
HDNBA	Household initiated	21096	22595	23876	23106
HDNBx	Household only	19882	21244	21949	21661
HDNBx.GDEFx	Household then followed by Government	1115	1230	1714	1295
HDNBx.HD~GD	Household followed by both government and Household	99	121	213	150

Table 7.2: Frequency of event sequences under the no bailout (**NOB**) strategy of default to debt limit (first left), the strategy of affordable level of debt after default (second), strategy of lowest level of debt after default (third) and right column is the target level/agreed strategy.

As expected, the changes are in the government default sequences and any spillovers are due to the government debt sequences such as in household default followed by a later government default (**HDNBx.GDEFx**). An interesting point to note is that government defaulting to an affordable level of debt reduces significantly the number of government default sequences (**GEDFx**), nevertheless, increases the chance that a government default will induce a household default (**GDEFx.GDHDx**).

Turning to the always bail out strategy where we record the frequencies in Table 7.4. As we observe a marked increase in the total number of event sequences for the affordable default strategy. Moreover, a significant part of this increase derives from government defaults (**GDEFx**, as a part of the summary **GDEFA**), which is in stark contrast to that of the no bailout strategy. There is also an increase in the number of all bailouts, successful (**BAILS**) and unsuccessful (**BAILF**, **BFHDA**) that we would expect would align with **HDNBA** above in counts however, affordable is slightly elevated as a result of a bailout strategy. There is some interaction between these two strategies of bailing out and the public debt default. Some of this frequency may be put down to event sequences being shorter for those strategies generating

[4]With a NDL strategy we would expect that a sequence of events might go GDEFx, GDEFx, GDEFx..... end, compared with a lowest being GDEFx then ending the sequence.

lower public debt outcomes after default such as affordable and lowest over those of target 2/3 and natural debt limit.

Event	Default Description	NDL (HCDL)	Afford (HCPS)	Lowest (HCLL)	Target (HC23)
ALLxx	All defaults	28034	37491	30704	32696
BAILA	All bailouts (good or bad)	21034	23794	22573	23059
BAILF	Failed Bailouts on first attempt	1111	1737	1242	1310
BAILS	Successful Bailouts	19923	22057	21331	21749
BAILx.BFHDx	Bailout followed by failed bailout	34	58	42	43
BAILx.GDEFx	Bailout followed by Govt default	1077	1679	1200	1267
BFHDA	All non first attempt bailouts	123	249	144	182
GDEFA	All government initiated	6877	13448	7987	9455
GDEFx	Government only	6329	12819	5788	8352
GDEFx.GDHDx		120	225	1566	405

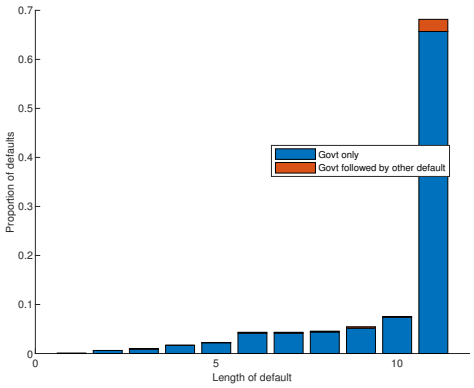
Table 7.4: Frequency of event sequences under the foundation (baseline) scenario (WITH ALWAYS BAIL OUT) strategy of default to debt limit (first left), the strategy of affordable level of debt after default (second), strategy of lowest level of debt after default (thrid) and right column is the target level/agreed strategy. Note some rows omitted for brevity.

This leads us to look at the distribution of durations of government event sequences which we illustrate as distributions of durations for each one of the default strategies (NDL, Affordable, Lowest,Target) in Figure 7.4. Our assertion that the duration of government defaults (**GDEFA**) is much longer when the target debt level is high (default to NDL, default to 2/3 target) when we compare with the lowest level of debt target. One interesting aspect is that defaulting to a target level of 2/3 NDL provides, on average, has shorter default sequence lengths than default to to affordable level of debt. One aspect is potentially interaction between the fiscal rule responding to the immediate change in debts, that then drives tax revenue down and government expenditures up potentially creating a follow on crisis within a couple of periods.

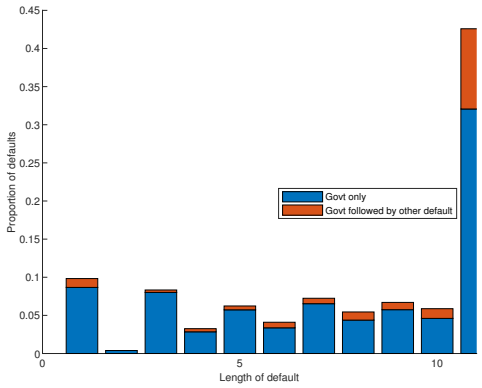
We should be able to observe this effect in the time-path analysis below. Likewise, the frequency of defaulting to the lowest level of debt strategy would have the same effect. As it starts at near zero level of debt, the fiscal rule response would still drive down tax revenue and increase expenditures that increasing debt quickly but not to crisis level within what the heuristic analyser determines as being an associated initial event. This draws us to a very specific issue: what is a reasonable period between events that would make those events independent? Increasing the parameter that determines the gap would possibly result in what are independent event sequences being coded into one event sequence, hiding valuable information. Nevertheless, shortening the independence gap may create a increase in the frequency of particular event sequences or other event sequences that relate to the originating sequences.

We use four periods (approximating to one year) as the maximum gap between events for the events to be associate into a sequence as a reasonable balance between repetitious sequences and creating spurious associations and sequences.

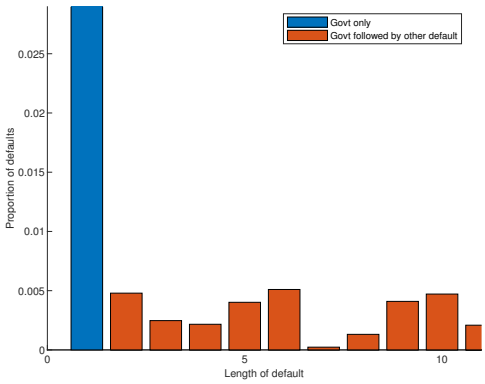
We therefore have two extremes that have significantly different outcomes on how long the economy is in sanctions imposed by foreign investors. Defaulting to the NDL keeps government in default for a long period of time whereas the alternative of defaulting to the lowest level of debt and returning to good standing quickly. Although defaulting to an affordable level does mitigate the effects of a NDL default by shortening the duration of the event sequence, nevertheless, surprisingly the target 2/3 debt default gives a better outcome for the economy and the foreign investor reduces their losses.



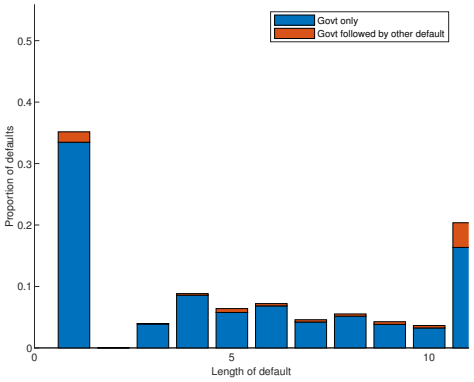
(a) Foundation scenario - No bailout and default to NDL, Government defaulting sequence



(b) Foundation scenario changing to default to affordable level of debt, , Government defaulting sequence



(c) Foundation scenario changing to default to lowest level of debt,, Government defaulting sequence



(d) Foundation scenario changing to default to a target level 2/3 of the NDL, , Government defaulting sequence

Figure 7.4: Distribution of the number of time periods in an event sequence for Government initiated defaults

7.3.2 Time Paths - Default to NDL

Full analysis of default to debt limit is in Chapter 3 and draw on that here with the main time-path illustration for government initiated defaults Figure 7.5. Key key feature that reinforces

the conclusions drawn above is the persistence of public debt $d^G$and the degree that haircutting goes on during the event sequence tail. Every haircut, the foreign investor is loosing out and likewise the economy is being constrained by the imposition of sanctions. Until the tax revenues increase and expenditures decrease though the fiscal rule ψ then the government will continue to default on public debt as it does not have sufficient primary surplus to service the debt at the NDL. We use this foundation as the baseline.

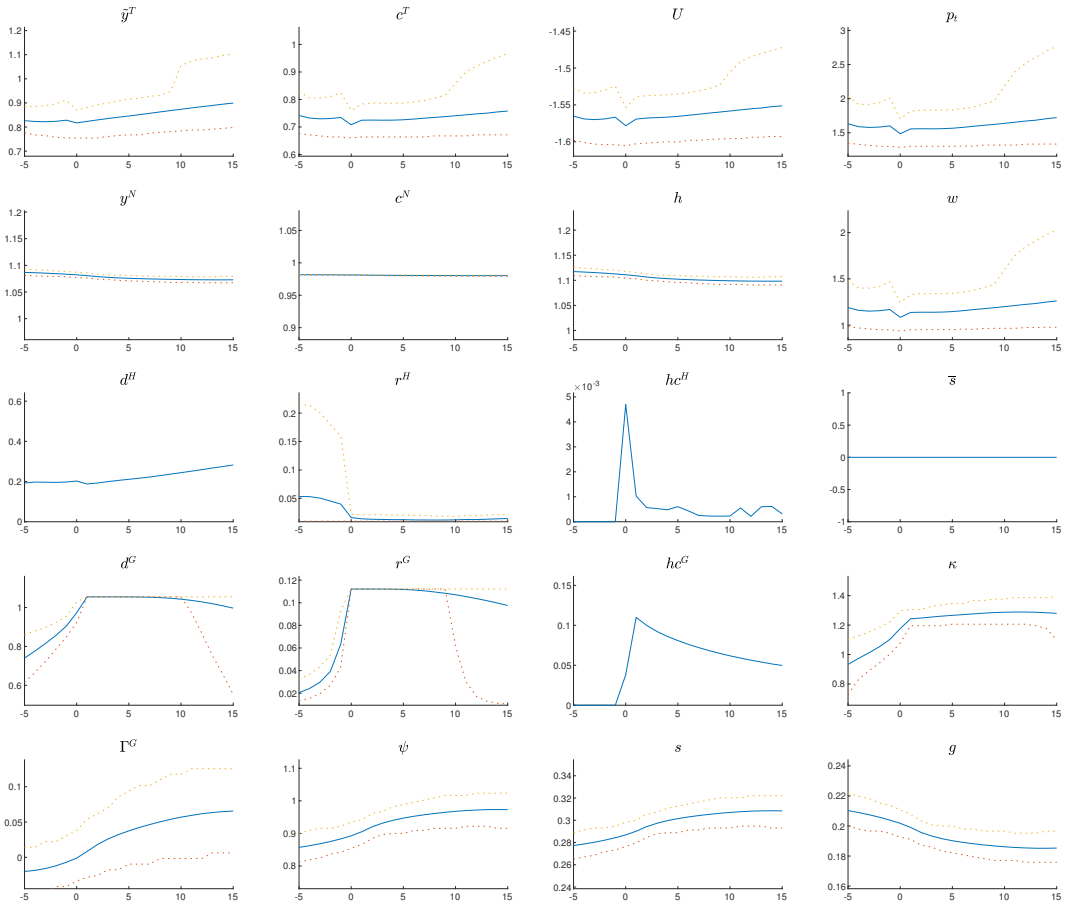


Figure 7.5: **GDEFA** - Government initiated default - Default to the Natural Debt limit

7.3.3 Time Paths - Default to Affordable Level

In contrast the the defaulting to the NDL (see Figure 7.6), defaulting to an affordable level of debt reduces the debt burden immediately, however, a further defaults can occur less frequently in subsequent periods. The important aspect is on the household, although the private sector haircutting hc^Hseems to indicate a problem it is restricted to a small number of cases and not significant. Private debt, tradable consumption increase in tradable income as sanctions are only applied when the government defaults. The important aspect of the strategy is to avoid defaulting again after the initial crisis event. Our policy setting attempts to find the sustainable level of debt, however, it seems that it is still to high and the response to low levels of debt by the fiscal policy rule creates a situation where the primary deficit increases when the public debt is just about affordable. In such a circumstance with the fiscal policy rule set up in the foundation

scenario then possibly setting the debt below the maximum affordable would provide for a better outcome and meet the strategy objectives.

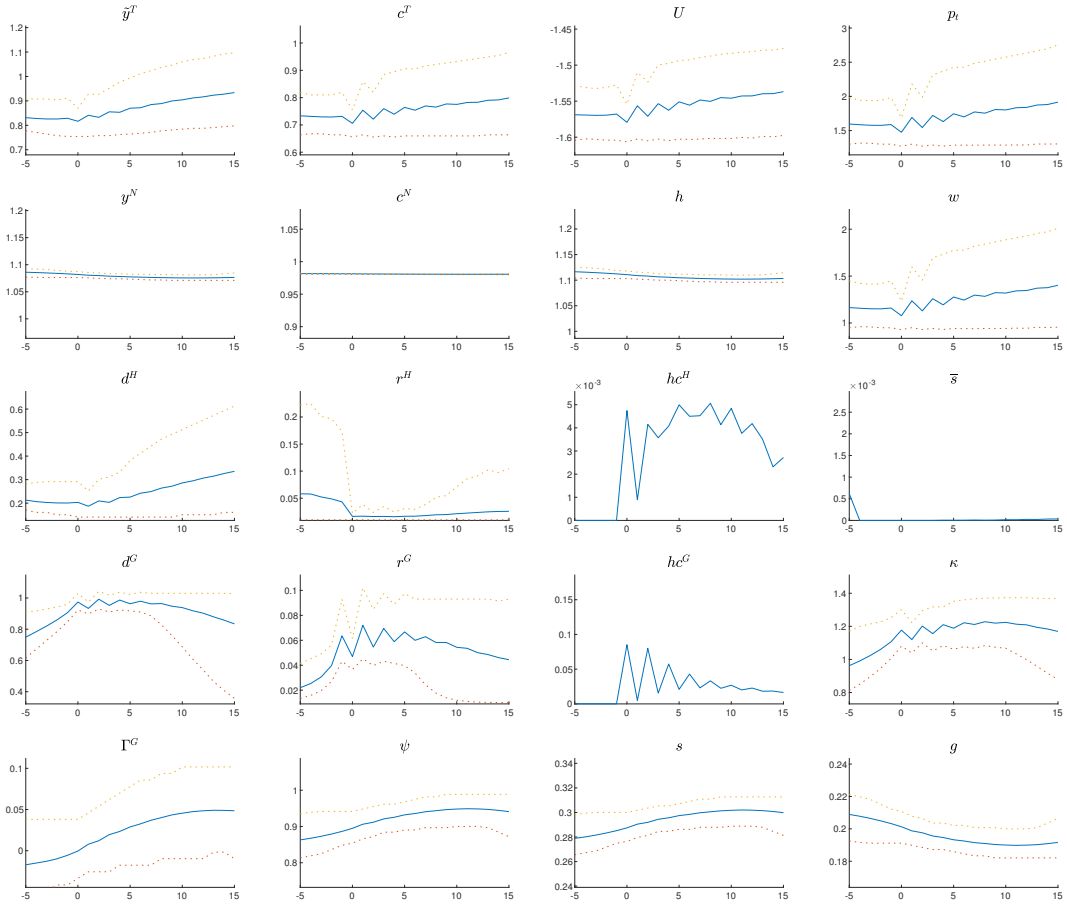


Figure 7.6: **GDEFA** - All events starting with a government default when Default to Affordable Level

7.3.4 Time Path for Default to Lowest Level of Debt

This strategy is the opposite to that of foundation, default to NDL. We illustrate the time paths of government initiated defaults in Figure 7.7 and this shows significant instability in the economy immediately after the crisis event. Observing d^Gone observes the crisis and default at $t = 0$ followed by a rapid increase in the government debt over the next seven periods to the next peak driven largely by the significant primary deficit Γ^Gthat immediately follows the crisis. The fiscal policy rule responds to the drop in debt pro-cyclically and this decreases the tax revenues by decreasing tax rates, With social transfers in the tradables sector, there is an increase in tradable consumption c^Tafter the crisis. This causes the price $p^T$to fluctuate that translates into domestic real wages. At the same point, labour increases in response to wages and domestic demand from government and to offset the rapid decline in domestic social transfers[5].

[5]We can make this statement as tradable social transfers follow the same path as government expenditure in the EXP fiscal ideology, hence, domestic social transfers must decline more if overall social transfers decline immediately after the crisis.

Even with the 15 period time window post crisis, we see a gradual return to stability; however, the pattern indicates further short term cycles. A point to note is that as we conjectured above when inspecting the frequencies and duration, defaulting to the lowest debt level puts off the next crisis event beyond that of our heuristic analyser boundary. Noteworthy is that the initial haircut by the government is significant and much greater than the combined impact of any other defaulting strategy. The only strategy that comes close is defaulting the the debt limit where the persistence accumulates successive haircuts that could be comparable to that of defaulting to the lowest level. We contend that both government and foreign investor would enter into negotiations rather than see the extremes of default with the potential for large losses and instability. Politically, the instability could cause civil instability especially if it causes a widening of inequality.

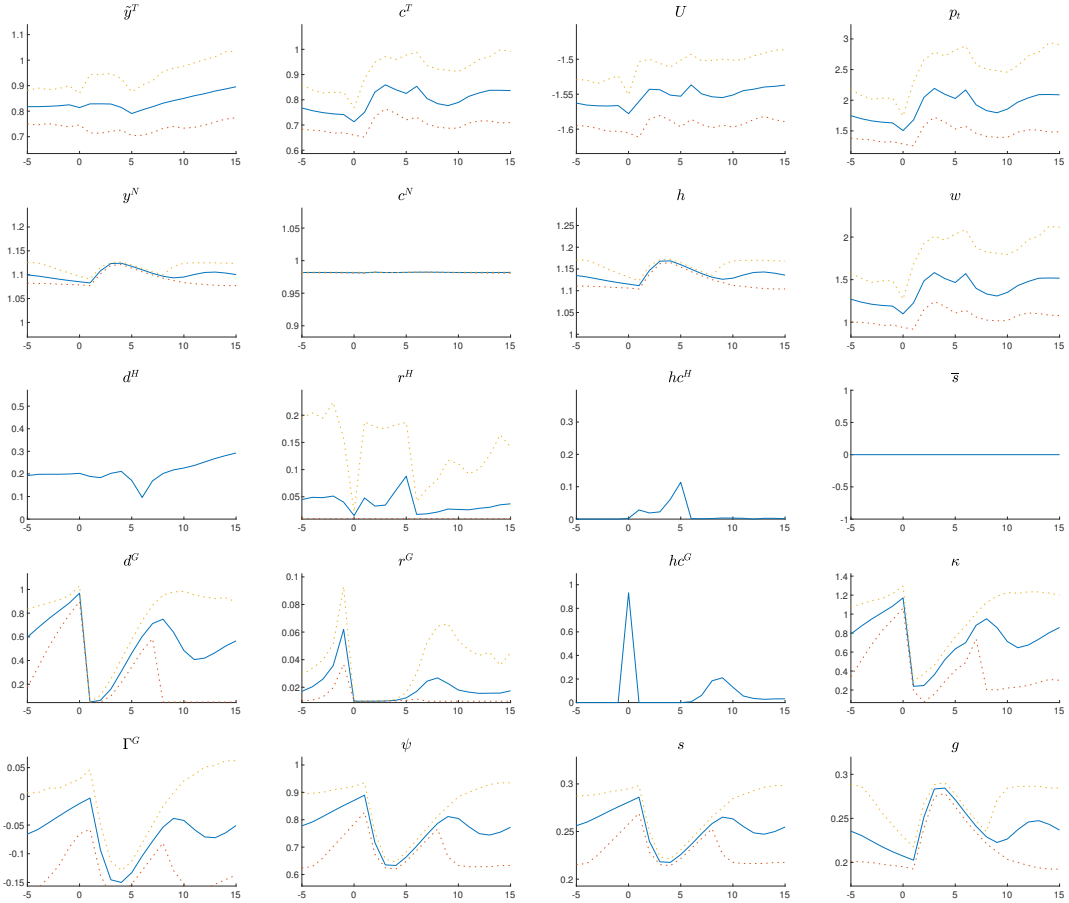


Figure 7.7: **GDEFA** - All events starting with a government default for defaulting to the lowest level of debt

7.3.5 Time Path - Default to Target 2/3 Debt

Our final strategy for consideration is defaulting to the 2/3 debt level after potentially a short negotiation (see Figure 7.8). This reduces the debt level below that of the NDL however, it is likely to be higher than that deriving from the affordable develop level strategy. A key point to note is that public debt d^Gdefault reduces debt sufficiently that any follow on default are very

much smaller than those of a default to NDL. Furthermore, the small reduction in debt does little to change the fiscal policy rule that affects tax revenues and expenditures, therefore able to generate a primary surplus that limits the necessity to borrow immediately after a crisis.

Although the haircut is comparatively small to those of affordable and lowest level strategies, it is sufficient to stop public debt being trapped in the NDL post crash defaulting sequence and it is sufficient to prevent the fiscal rule creating another crisis. Another aspect to consider with this moderate haircut is that of economic stability in labour-wage and tradable and domestic consumption and output. We do not observe the effect of the NDL and its repetitious defaulting causing the imposition of sanctions, nor that of defaulting to lowest level with a fiscal policy potentially creating instability. This implies that somewhere between NDL and defaulting to the lowest level is an optimal defaulting strategy for the government taking into account both fiscal rule and ideology settings.

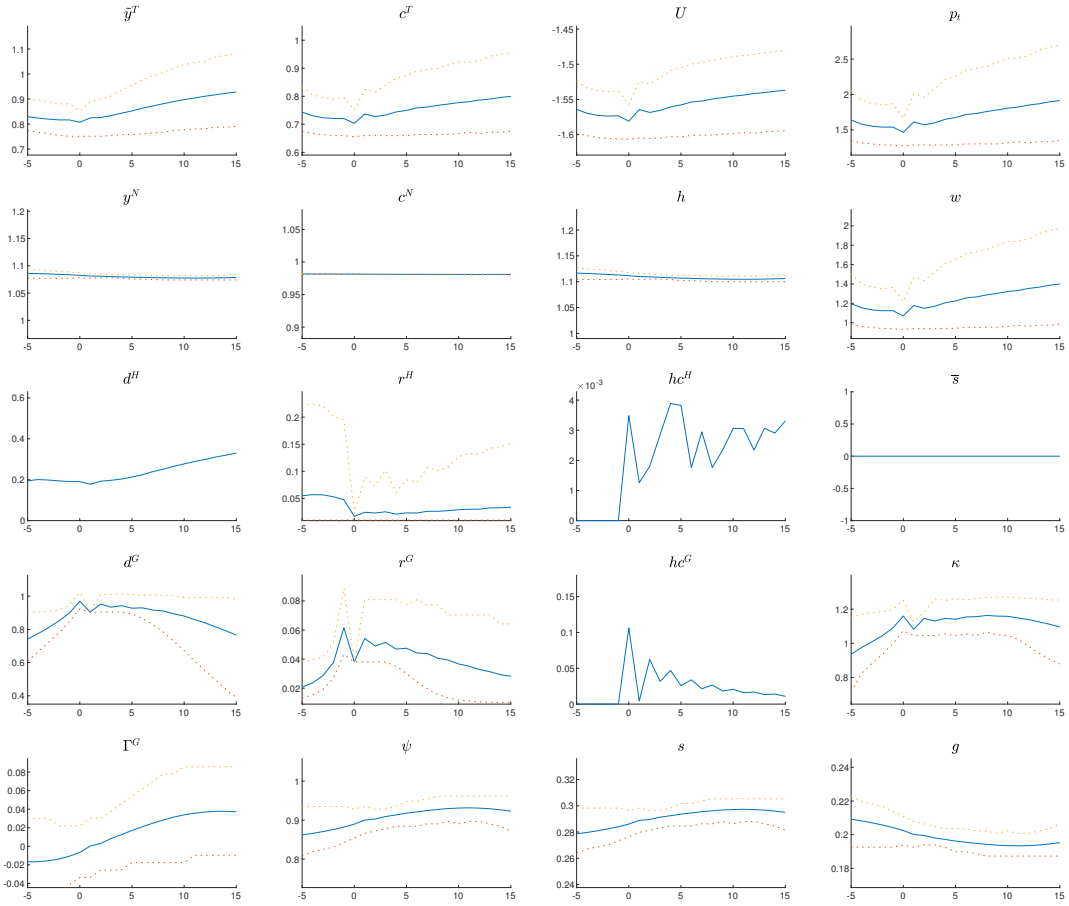


Figure 7.8: **GDEFA** - All events starting with a government default where default is to a target level

7.3.6 Time Path Comparisons

In 7.9 we compare the core variables for each one of the strategies, side by side. From the top, the stochastic process y^Tsets the levels for $\tilde{y}^T$with the only other influencing factor being the loss function with the imposition of sanctions. All show the same trend of recovery, however,

the variations are from the effect sanctions imposition. For example, the default to NDL has repeated haircuts with the imposition of sanctions that attenuate tradable income until there is sufficient recovery in the primary surplus Γ^Gas government implements a limited set of austerity measures on Government expenditures and social transfers in the tradable sector. This is in somewhat contrast to that of defaulting to affordable and the target default where after the initial crisis, there may be some follow on events that cause the imposition of sanctions (the ripples in $\tilde{y}^T$ indicate successive sanctions impositions) albeit short lived by comparison. As a result, the economy grows quicker from those two strategies than the foundation defaulting to NDL.

One interesting aspect is that defaulting to the lowest level causes a double dip recession in both the tradable and domestic sectors. The wide fluctuations is fiscal policy though the feedback mechanism of the fiscal policy rule implements expansionary measures in the tradables sectors and with the expansion of domestic government expenditures, the residual domestic social transfers s^N declines markedly. An explanation is that this is part of the government budget constraint in the domestic sector where the revenues from taxation must be in balance with the government expenditures and social transfers. This specification, social transfers carry the residual, nevertheless, government expenditure could carry the residual and social transfers set algorithmically. For example, unconstrained social transfers is a function of the tax rates for consumption and income, and government expenditure that are modified by the fiscal policy rule (7.25). Likewise, constraining social transfers swaps government expenditures for social transfers as in (7.26) and would give very different outcomes graphically.

$$s_t^N = \tau^C \psi_t c_t^N + \tau^Y \psi_t w_t h_t - \frac{g^N}{\psi} \tag{7.25}$$

$$g_t^N = \tau^C \psi_t c_t^N + \tau^Y \psi_t w_t h_t - \frac{s^N}{\psi_t} \tag{7.26}$$

The important part of defaulting to debt limit is that the reduction in tax revenues and increase in expenditures in the tradables sector creates a persistent primary deficit $\Gamma^G$and as such causes public debt to increase that induces a government response in increasing tax rates and reducing expenditures that then causes another recession 5 periods out from the original crisis. Whether that recession causes another public debt default or not rather depends on the level of tradable income y^T. Moreover, such contractionary actions by the government force households to deleverage at the time of the recession, Deleveraging causes a mini-dip in consumption and has a moderating effect on consumption in the longer run.

For interest and comparison, it worth inspecting if there are any interactions between no bailout and bailout. We maintain the same fiscal policy rule and ideology parameters, only changing to always bail out. In all four scenarios, the main difference is in public debt defaulting to lowest level (**HCLL**) tradable consumption, labour-wage and private debt paths. Note at period $t = 5$ post crisis event, the household receives a bailout $\bar{s}^T$indicating that in the no bailout situation,

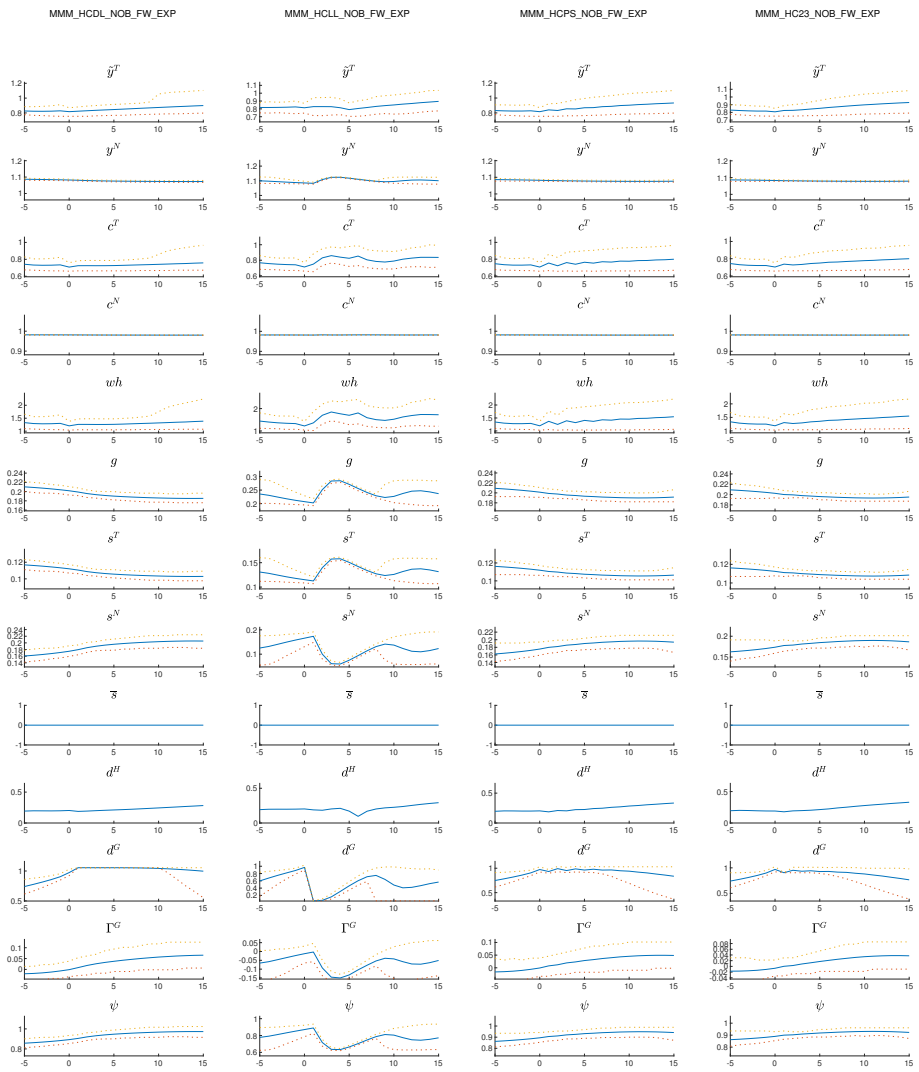


Figure 7.9: Comparison of scenarios in a Government default sequence. From left to right: Haircut to debt limit (HCDL), Haircut to the lowest level of debt (**HCLL**), Haircut to an affordable level using the primary surplus as a basis (**HCPS**) and Haircut to a target of 2/3 NDL (**HC23**)

private debt default occurs in some of the sequences. This smooths out consumption, labour-wage and non-tradable income. We can conclude that the instability is partially addressed by government bailing out the household. As this is five periods after the crisis and there are likely no conjoining events in between, this means that this default event is separate from the public debt default event in the analysis tool. We can conclude that some of the bailout (**BAILA**, **BAILS**, **BAILx** in Table 7.4) or bailout refused events (**HDNBA** in Table 7.2) in this scenario are likely to have some association with the earlier government default event. This implies that (**BAILA** and **HDNBA**) are artificially high and that government default event sequences are, in some cases, longer than implied by (7.4c).

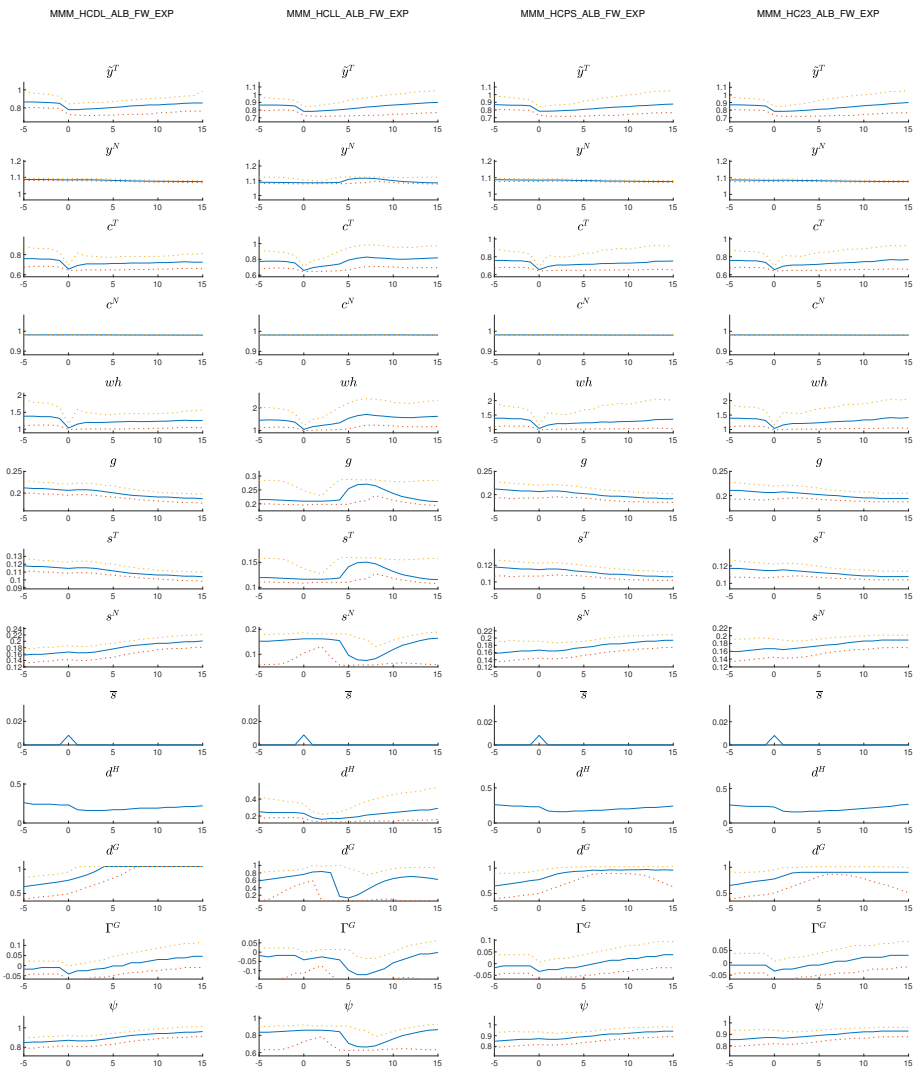


Figure 7.10: Comparison of scenarios for bailout with public debt defaulting strategies of default to the NDL, default to the lowest level of debt default to an affordable level of debt and default to a negotiated target level of debt.

7.4 Conclusion

We introduce a unique analysis to our foundation model with government strategies to handle public debt default. We model the extremes, namely defaulting to the natural debt limit and to the lowest level of debt, as well as two cases that seem more relevant to real world circumstances. The norm in most of the literature is a default to the lowest level of debt. We contend that this is rare for two main reasons. First, the public debt portfolio normally has a range of durations and expiration dates; not all debt expires at the same time. Default occurs when the government does not have sufficient resources, either as a primary surplus or as revenue from new debt issuance, to repay the current debt. Hence they will haircut some of the outstanding debt that is due at that time. Second, many defaults have a strategic element to them. The Foreign investor may be forced to into negotiation to accept a larger haircut in the face of government defaulting on all debt. The threat implies that some level between the NDL and lowest level of debt is more appropriate as a means of reflecting a settlement. Hence we introduce two

additional default levels of debt: first to an affordable level, second to a negotiated level.

What becomes apparent is that the defaulting to the natural debt limit, although may limit the haircut in the short run; in the long run, the losses for the foreign investor are very significant. The impact of sanctions on the economy are a factor to consider, as repeated defaults cause similar sanction events until the economy eventually generates sufficient primary surplus to service the debt. This is a common sequence where countries repeatedly default until some the implementation of corrective measure, normally some form of austerity programme. The other extreme, defaulting to the debt limit may give the economy respite from sanctions; however, it has the potential to lead to instability across both tradable and non-tradable sector, and eventually lead to a private sector default and a double dip recession. Again, what seems to have merit to the country may, in the long run, make the country worse off in both stability and successive cyclical recessions.

This leaves us with with considering two strategies that sit somewhere between. One would expect that defaulting to an affordable level using current primary surplus would render a better outcome that the two extremes. However, we find that this strategy does not necessarily resolve the problem and may create short period defaulting cycles until sufficient primary surplus. Maybe there is a point lower than our algorithms identify that would provide a better outcome. One advantage over default to the lowest level is that is it more stable in both government and household finances; nevertheless, it is less stable than defaulting to the debt limit. One advantage is that sanctions are only intermittently applied to the economy and allow a much more speedy recovery than either of the extremes.

Finally, defaulting to a negotiated level of debt, in this case 2/3 NDL. This keeps debt high, however, not to the level where repeated defaulting occurs as in the NDL scenario. The fiscal policy rule ensures that the primary surplus is ramped up much as in the affordable to cover the debt service costs. This implies there is a optimal level of debt to haircut to taking into account the policy rule settings and parameters with the state of tradable income. Of course, the closer a negotiated agreement is to the extremes, the more that it will behave like those extremes.

An important aspect is the role of fiscal policy rule and how much it is influenced by debt. As we observe in Chapter 5, fiscal policy rule can turn a fiscal ideology that is progressive tax and social transfers regime into a austerity policy if one makes the focus about debt. Increasingly, governments, at the behest of much academic research, have focused on public debt. Furthermore, NGO's such as the IMF, World Bank and the EU commission have imposed severe austerity measures on countries heading towards or are in default. Originally, the Paris Club was purely to minimise the losses to foreign investors, this over the last 30 years has taken a much more progressive approach noting that severe austerity measure have a disproportionate impact on the most vulnerable sectors of society. Such effects can lead to socio-political instability that actually works against the foreign investor. What we show is that rather than taking a hard line, government and foreign investor are better to negotiate a pathway out of crisis, taking on the losses whilst maintaining economic, therefore socio-political stability. Unfortunately, modelling something that is akin to affordable, acceptable given a set of policy

parameters and economic circumstance could only be done on a case by case basis. However, there may be one or more optimal points where foreign investor and government can achieve mutually beneficial outcomes.

Chapter 8

Labour, Wage, Exchange Rate and Fiscal Realisation

8.1 Introduction

To this point, we have only considered flexible wages, floating exchange rates and a moderately expansionary fiscal policy in all of the previous scenarios. This chapter explores downward wage rigidity with fixed exchange rates starting with the ideas in in Na et al. (2014) and it follows with some preliminary work on looking at how fiscal policy rule is realised into tax rates and government expenditures. Again, we are basing this on the Foundation scenario only changing the wager for fiscal realisation settings, all other parameters and strategies remain the same.

We create some new scenarios to explore the effects on government, employment, wages and consumption. The presentation of this chapter follows in similar lines to prior chapters in comparing frequency, duration and time-paths of default sequences. In the first part of this chapter, we consider the flexible and a downward wage rigidity with fixed exchange rates and in the second part is more of a thought experiment to conduct testing different fiscal ideologies in the context of foundation scenario.

8.2 Wage Flexibility, Labour and Effective Demand

The foundation flexible wages principle implies that labour will accept any wage to remain employed, thus the level of wages adjusts rather than labour. Therefore firms maintain the same level of output by reducing the price of output with a commensurate adjustment in the labour wage. Social transfers and non-lump sum taxation do have a distortionary affect on both labour and consumption. In the current model, what government does not expend from taxation on domestic goods, is returned in social transfers. Therefore the only distortionary affect is the level of output and any differences in the taxation rates for consumption and labour. Following this classical view that real wages are self adjusting maintaining a near practical

full employment or that there is some friction that lessens the effects of a perfect competition thus creating unemployment. We introduce into the foundation model an extension that makes nominal wages have a downwards rigidity following the ideas set out in Schmitt-Grohé and Uribe (2016a)[1]. Another aspect to consider is the price of non-tradables and tradables in the context of a variable exchange rate effects on wage. We note from the foundation scenario analysis in Chapter 3 that exchange rates can adjust to the economy therefore, real wages follow price that follows the differential between tradable and domestic consumption. By removing nominal wage reductions and fixing the exchange rate then we should observe the effects of crises in changes in employment rather than though the wage mechanism. This implies that workers prefer unemployment over a real wage reduction juxtaposed to firms releasing labour because of insufficient demand for their output. Its worth investigating this contradiction between classical economic modelling in an RBC environment and that of observed employment norms.

Back to the motivation of downward wage rigidities (DWR), namely, trying to induce some form of change in employment labour hours rather than changes in wage rates. There is some empirical and theoretical support for some form of wage compression causing unemployment as Barattieri, Basu and Gottschalk (2014) and Elsby (2009) illustrate Many developed economies have a lower bound to legal wage rates including a minimum wage and unemployment supplements. Furthermore, Keynes argues in Keynes (1936) that'nominal wages display downward rigidity, that is workers are reluctant to accept cuts in nominal wages'.

The literature's suggestion that DWR and minimum wage have a significant bearing on unemployment inducing behaviour, particularly in a crisis or recession. Since the 1980's, there is consistent political pressure to reduce the minimum wage in real terms, particularly in the US and the UK in the name of labour market flexibility. These is a supply side argument suggesting that workers rather take unemployment than a pay cut. This neglects labour market conditions, that is if there market is buoyant then workers are less likely to entertain employer's reductions in pay whereas a market characterised by mass unemployment list likely to accept nominal pay cuts especially if there is little in the way of unemployment supplements (Shapiro and Stiglitz, 1984). Again, this does not necessarily explain how DWR logically induces unemployment. Normatively, firms suffering a downturn in demand for their goods will employ a number of strategies to reduce the cost of labour whilst retaining engagement at equivalent wage rates. This includes no overtime, short time working, recruitment freezes before employers consider voluntary redundancies, early retirement and finally, compulsory redundancies. Of course, the nature of the workplace has transformed with the sensualisation of labour that could be more akin to a rigidity in both directions. We would argue that Keynes postulate that only when near full employment will labour be unwilling to accept lower wages has merit as uncertainty of income drives household behaviour.

Another aspect to consider on using wages flexibility to maintain employment is that if governments need to provide additional services and subsidies to households for low wage indi-

[1]Rather than repeat the the comprehensive analysis in Schmitt-Grohé and Uribe (2016a) regarding wage, labour and unemployment, we refer readers to that article for the theory and analysis. Our focus is more on debt and if a wage rigidity has a material impact on public or private debt.

viduals, is that not just an indirect subsidisation of the firms that offer low wages? As Ricardo stated, workers will work for a subsistence level of wages and not below, setting a lower bound for wage income. Ideally, the minimum wage needs to be at least above that of subsistence levels which in economic terms would place those wages above the marginal product. Furthermore, imports, goods in particular, from low wage & cost economies could effectively create unemployment making domestic industries non-viable. This may reduce the price of imported goods and provide access to goods that were out of reach for the many, however at what cost? This combination of below subsistence wage income, government subsidies, lack income security with cheap imports does not provide for a stable socio-political system that can sustain the impacts of a crises.

One aspect of labour economic thinking in this style of model is that labour skills and other factors remain largely constant regardless of their employment status. Unfortunately, unemployment has a significant impact on current skills, continuing skills development, workplace know-how that effectively depreciates the value of the labour force, particularly in certain professions (Ortego-Marti, 2017; Pavoni, 2009). Furthermore, The psychological impacts on both individuals and communities cannot be overstated regarding unemployment that are often neglected by economists.

There is always going to be a Schumpeterian creative destruction process that will require the workforce to change, reskill and adapt to new working environments, however, this affects lower income households and communities are particularly in times of crisis (Kapuvari, 2011) leading to a breakdown in civil society and distortions in the political system (Chambers and Kopstein, 2001). The nature of unemployment and its effects on skills, work ethic, not only reduces the income levels for those out of work, the psychological impacts can create intergenerational disillusionment and scaring (Arulampalam, Gregg and Gregory, 2008). This in turn has a dramatic effect on the labour force's resilience to crises and ability to adapt to changing circumstances. Clear examples exist in the Rust Belt of the United States, the South Wales and Yorkshire Coalfields, UK Midlands manufacturing where industry's demise was hastened by a combination of Schumpeterian creative destruction, repeated crises and failures of successive governments to address the societal impacts. Unfortunately, these feedback loops do not mix well with tradition of utility functions, equilibrium or parsimonious models, rather that they fit into the realm of stock flow consistent and/or agent based models where their may be multiple local equilibria.

As we observe in the 2020 Crisis, government policy across Europe and Australasia is to keep employees attached to their work and to provide sufficient wage supplements to ensure that they can meet their base level of essential consumption and for firms to effectively hibernate during the worst times. Although those workers on furlough are effectively unemployed or under-employed, they remain connected to their employer. This means that firms have access to their trained labour force when and if they need them and removes some uncertainty from the employee. Albeit, some will not return as a result of the crisis either voluntary or involuntarily.

This is in stark contrast to that of the US where lay-offs are reaching record levels and the

possibility for a firm to re-engage its trained workforce easily is somewhat compromised[2]. Although there is some extensions to unemployment assistance, although time-limited, there is a significant part of population that has not met its basic housing and well-being needs. In both cases, one can foresee significant company restructuring creating long term unemployment that has not been seen in places like the UK since the 1970's and 80's. Households are likely to be reluctant to spend on less essential items with an environment of uncertainty about future income streams. So is it labour supply at a price is the issue or is it firms having to address the lack of demand for their output?

If we continue with the tract in the Neoclassical style ideology then we can turn to Ohanian (2010) to explore the the adverse impact on labour when comparing it to capital. This paper notes that the 2008 crisis had a significant and real impact on labour input, however not the same impact on capital returns. The issue with this article is that it fails to understand the flow of credit compared to the stock of private debt. De-leveraging, that is a negative flow of credit, means that the private sector firms and households have to produce sufficient surplus to fund repayment of stock of debt and the interest accruals. This materially impacts household consumption that affects firm's revenue stream. A contracting revenue stream leads firms to divest labour as we describe above. Furthermore, in debt markets, it is the volume of trade matters, when trust is eroded, then trade freezes and the normal flow of liquidity that 'lubricates' operations at both a financial institution and at corporate level.

A significant part of regular liquidity drain on firms is labour wages that have to be paid regularly, therefore firms, without support such as the furlough schemes of the 2020, will release labour to prevent liquidity insolvency. The government's actions are to create stability in the liquid debt markets by effectively underwriting corporate and financial institution debt. These only address the supply side issues, not demand for output. This is a fundamental ideological difference between this example neoclassical analysis and that of a effective demand model.

To this point, we have entertained Say's law, where as Keynes said 'Demand will meet Supply' (Keynes, 1936) that he rejected, particularly in a crisis. Moreover, he suggests that there are at least two equilibria at extremes in an economy, at one end of the spectrum, being the full employment state, the other end the subsistence state. The upper near full employment state is subject to events that could result in the economy declining into the subsistence state, hence, we can deduce from Keynes and Kalecki more insightful analysis that the near full employment state is less stable than the subsistence state. This leads us to the idea of the entrapment of the economy in the subsistence state is somewhat parallels that of the 1929 to 1933 US Great Depression, something that Keynes himself drew and reflected in Skidelsky (2018). The core difference between the Say's law and Effective demand is Say's uses prices (goods and labour) to adjust to supply whereas Effective demand uses investment and the motivation to invest by as the adjustment mechanism that determines labour and real labour wage (Dalziel and Lavoie, 2003). If demand is deficient then, there is an over supply in the economy and nominal prices may experience a deflationary spiral. Hence, firms will divest from labour first and then cap-

[2]There are a number of other issues with disengaging the workforce in the US in that many of the health and well-being services are tied to employment

ital.[3]The reduction in labour reduces aggregate labour income that in turn reduces demand for goods. Any reduction in aggregate labour income, particularly on the lower income brackets, is likely to reduce effective AD, leading to a lower, possibly subsistence, equilibrium. The paradox of thrift for firms trying to maintain profits implies also that the labour share of income will also reduce. Hence we have another effect, that being a widening wealth gap between waged labour and capital investors. This leads us to the discussion in Chapter 5 and Chapter 6 regarding government intervention and creating effective demand though household using bail outs. As in Arulampalam, Gregg and Gregory (2008), continuing unemployment has a long term effect on the productivity of labour. We could draw that a low wage environment would also have a similar effect.

During the past 20 years, many European (Excluding Germany) and the US have seen a stagnation in labour productivity and real wages whilst there is a steady increase in private debt to fund consumption. Most of the lower socio-economic deciles have little in the way of insurance though saving and are reliant on labour wage to sustain them. One could conjecture that post 2008 crisis, the UK and US economies never fully recovered and are sitting at some lower nearer to subsistence level. Only time will tell if the 2020 crisis will lead to another lower equilibrium level. Already, firms are indicating that they are likely to lay off workers once government interventions tail off.

One aspect that erodes the consumer's power to demand is the inflationary effects on nominal wages as well as any employer driven wage reduction. In our model, a rise in prices effectively depreciates the domestic currency causing the corrections that we have already seen in the foundation model. We shall explore if a nominal wage rigidity has any impact on the deflationary and inflationary effects of a crisis. This model is somewhat limited in its ability to simulate a crisis event that has multiple equilibria, however, by using a combination of fiscal policy rule and fiscal realisation that we discuss in the next part of this chapter does provide some similarities to a multiple equilibria unstable environment.

8.2.1 Changes to the Model and Foundation Scenario Operation

We take the foundation scenario in Chapter 3 and extend it with an additional constraints on wages and exchange rates. This is equivalent to pegging the domestic currency to a the international currency that we observe in many countries round the world. Commonly, either the government has a policy of pegging or there is a de facto pegging in that much of the domestic trade is in the international currency. We often observe this in countries where the domestic currency does not show stability, perceived to be over valued or an extended period of inflation. Moreover, countries such as many of the southern European bloc that are members of the EU and the EURO currency experience that their domestic goods experience significant price fluctuations as they cannot use one weapon in the monetary armoury, namely, depreciation of domestic currency. Post 2008 financial crisis we note in most of the southern European

[3]Labour has a flow cost to the firm whereas capital can effectively be mothballed and largely only the fix rate of depreciation will have an impact. Furthermore if the economy is experiencing a downturn then the demand for capital goods including land and buildings will diminish. We observe this on a regional basis in all developed countries.

countries as significant progressive decline in real wages mixed with an imposed austerity programme to address what is deemed as excessive government primary deficits and rising public debt.

The two aspects are: a downward nominal wage rigidity and fixed exchange rates. Here, we will only show the differences in the model specification. Please refer to Chapter 3 for the details of the full model. We start with prices and inflation. The gross inflation rate is the ratio of prices based on the last period. As $p_t = \frac{P_t^N}{P_t^T} = \frac{P_t^N}{\varepsilon_t}$and then the inflation rate for the current period is:

$$\epsilon_t = \frac{\varepsilon_t}{\varepsilon_{t-1}} \tag{8.1}$$

As a result, firms make nominal profits derive from the revenue from production less the labour wage cost thus:

$$\varepsilon_t \Pi_t = P_t^N y_t^N - W_t h_t$$

However, although labour supply is flexible, wages are not. Firms experience a downward nominal wage rigidity where households will only supply labour if nominal wage rates are maintained near or above the previous period's rate. This characteristic is prevalent in many developed and developing economies (USG and others) where wage inflation is unlimited, however households see wage deflation as negative and rather not have the income. therefore:

$$W_t \geq \gamma_w W_{t-1} \tag{8.2}$$

Again, normalising into tradable prices ${}^{w_t}/_{\varepsilon_t} \geq \gamma_w {}^{w_{t-1}}/_{\varepsilon_{t-1}} \rightarrow w_t \geq \gamma_w {}^{w_{t-1}}/_{\epsilon_t}$. Firm profits are subject to the wage wage deflation constraint. Note that real wages in foreign terms may fall much more as inflation reduces the value of the domestic currency.

$$\pi_t = p_t F(h_t) - w_t h_t \tag{8.3}$$

$$w_t \geq \gamma_w \frac{w_{t-1}}{\epsilon_t} \tag{8.4}$$

However, if the exchange rate is hard pegged then $\varepsilon_t = \varepsilon \; \forall \, t$ hence, $\epsilon_t = 1$ therefore from 8.4 we have that real wages are downward rigid:

$$w_t \geq \gamma_w w_{t-1}$$

The combination of a hard peg and a downward wage rigidity should alter the dynamics of both a private debt crisis, and that of a public debt crisis. We will consider four scenarios, namely the foundation with flexible wages (See Chapter 3) contrasting the same settings with a wage rigidity. Both these scenarios are no bail out policy response to a private debt crisis,

therefore it is important to consider a bail out situation as well. We have a baseline bailout (foundation model with a bailout policy response) and bailout with a wage rigidity/pegged exchange rates.

8.2.2 Simulation Results

We will assume that the reader is now familiar with the foundation scenario time paths that form the baseline for the no bailout, flexible wage and wage rigidity comparison and only include them in the cross scenario comparisons. Below in Table 8.2 shows the frequencies as an account for the scenarios under consideration in this chapter. Comparing the foundation (the left column) with the introduction of a wage rigidity (second left) we note a marked decrease in the total number of event sequences (**ALLxx**) by 25% that particularly translates into a near 50% decrease in government initiated default sequences (**GDEFA**) and a smaller reduction in the household defaults (**HDNBA**). An interesting point is that wage rigidity creates a situation were initially a household default leads to a household and government default (**HDNBx.HDGDx**) as well making up 30% of the total default sequences.

Event	Default Description	Flex wage No bailout	Rigid Wage No Bailout	Flex Wage bailout	Rigid Wage bailout
ALLxx	all events	27734	20999	28034	27964
BAILA	All bailout good or bad	0	0	21034	20979
BAILF	First attempt failed bailouts	0	0	1111	1107
BAILS	Successful bailout	0	0	19923	19872
BAILx.GDEFx	Bailout followed by Government default	0	0	1077	1073
GDEFA	All government defaults	6638	3733	6877	6863
HDNBA	Household default, no bailout	21096	17266	0	0
HDNBx.GDEFx	Household default followed by government default	1115	715	0	0
HDNBx.HDGDx	Household default followed by household and government default	0	5596	0	0

Table 8.2: Event sequence Frequencies the flexible and wage rigidity with a policies of no bailout and bailout

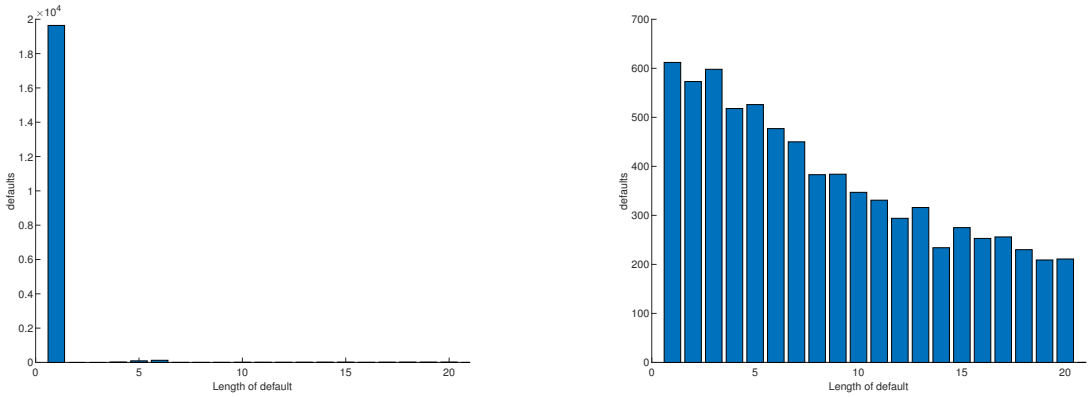
The important aspect here is the private sector crisis turns into a private and public sector crisis in that sequence. If we compare this with the bailout scenarios (the two right hand columns) we can see that the government bailing out the private sector prevents such a sequence developing[4] when there is a wage rigidity/pegged fx. Although government defaults less on its own with a wage rigidity that any other scenario under consideration, if the private sector gets

[4]if the same sequenced was to occur under bailout then we should see the **BAILx** followed by a combined government and household default, that is **HDGDx or BFGDx** depending on the sequence.

into trouble then choosing not to act creates a greater chance that it will induce a public sector default as well. We can liken this to the Greece situation during 2010 to 2012/4 where the a private sector crisis eventually lend to a public sector crisis. One aspect that is different, Greece was effectively forced to bailout its financial system and then impose austerity measures as a result of debt. With regard to frequency under bailout, wage rigidity seems to have no significant impact on the frequency or distribution of event sequence classifications, therefore we draw that bailout does in some way mitigate the effects of a wage rigidity and a pegged fx. Next is to move to looking at the durations of public and private sector initiated crises.

8.2.2.1 Wage Rigidity With No Bailout

Although the frequency of public sector defaults decreases under a wage rigidity, the distribution of event duration is similar, as we illustrate in Figure 8.1. As we have discussed before, the effect of defaulting to the debt limit increases the length of the crisis. Nevertheless, when it comes to a private sector crisis, we have a significantly different outcome. A flexible wage regime tends to keep the private sector defaults short as we illustrate in Figure 8.1a, whereas the wage rigidity and pegged exchange rate increases the duration and the likelihood of a long duration markedly, as we illustrate in Figure 8.1b. What this implies is that the domestic economy's inability to adjust affects the tradable side of the economy making the crisis much worse. We should observe this effect in the time-paths for a private sector crisis (**HDNBA**).



(a) Flexible wage, floating exchange rates with no bailout

(b) Wage rigidity, no bailout

Figure 8.1: Flexible and a wage rigidity effect on the duration of all defaults

In analysing the time-paths, lets consider a public sector default first, as we illustrate in Figure 8.2. The graphs indicate that there is a long run into the default sequence where the tradable income stochastic process has suppressed the economy for some time before. This we show with the increasing levels of government debt d^G and a primary deficit. Note the particular

'hockey stick' shape of the the interest rate r^G. As we have already discussed, there is a tipping point in government debt where the almost certain outcome is default. Only if there was a rapid increase in a primary surplus could the government reverse the situation. Moreover, private debt $d^H$is at a low level indicating that households have been deleveraging prior to the event and suppressing tradable consumption. The effect is that households tend to then work more to make up for the lack of consumption, that is h is increasing. However, real wages w are being suppressed and the decline in price differential p tradable and domestic goods indicating inflationary pressures in the domestic market[5]

The increasing utility, except for the crisis point, derives from domestic consumption. Part of the domestic consumption is funded though increasing levels of social transfers s^N. Note that in this fiscal realisation, tradable social transfers are declining following the path of government expenditures g. Therefore government policy is in-part creating the additional domestic consumption, hence improving the standing of households. One aspect of the wage rigidity is that government debt remains in default for much longer than the equivalent foundation scenario. Governments are effectively trapped and need to increase the primary surplus Γ^Gthough reducing tradable government expenditures s^T, g^T and increase the tax rates following the path of the fiscal rule ψ.

So does this seem to match a public sector crisis. If one inspects the charts in Schmitt-Grohé and Uribe (2016a) and Na et al. (2014) for Greece, Argentina the it follows many of the variables time-paths for a public sector default[6]. One aspect of this is that Greece in the 2012-4 crisis experiences follow very much these paths. Note that Greece had first a private sector crisis in 2010, bailed out the banking sector at the 'instruction' of ECB and European Commission[7].

Next we consider the private sector default sequences in Figure 8.3 where the household defaults with no bailout (**HDNBA**) as the start of the sequence. At the point of crisis, there is a marked drop in both tradable and domestic consumption ($c^T c^N$) flowing across from the progressive drop in household tradable income y^Tprior to the crisis. The imposition of sanctions has a dramatic effect across all both public and private sectors with government experiencing an immediate primary deficit Γ^G and an escalation in government debt. One aspect of this default that is quite different to most other scenarios, is that private debt remains near zero effectively locked out from foreign investment by a combination of high interest and sanctions.

[5]Price is a function of the ratio between marginal utility of tradable consumption and non-tradable consumption. if $c^T$is level and $c^N$is upwards sloping the the ratio is reducing and this indicates price differential between tradable and domestic is reducing though an increase in domestic pricep^N.

[6]These charts are silent on the private sector default, debt levels and interest rates.

[7]There is much conjecture that the main driver was German Government protecting its own as they many German financial institutions had invested heavily in Greek government debt as it was exhibiting higher than average returns within the EU boundaries. Furthermore, Greece was fairly close to many of the fiscal target and responsibility criteria (Commission, 2015) and the pre financial crisis analysis of debt b the rating agencies was, at best, poor at worst, criminal. Although the Greek Banks that German banks had invested in seemed to be only moderate risk, they did not take into account the significant systemic risk in the Greek economy. The Greek government book keeping and poor tax collection, as well as the grey and black markets that make up a not insignificant part of the economy leaves the government weak if there is a crisis. The 2008 crisis had amplified the stress on the Greek economy and government, therefore bailing out the banks had only one real outcome for the Greek public debt under a fixed exchange rate mechanism (the EURO), namely, public sector default. Post default, Austerity measures imposed by the Troka. saw a net decrease in GDP within 5 years of nearly 25%.

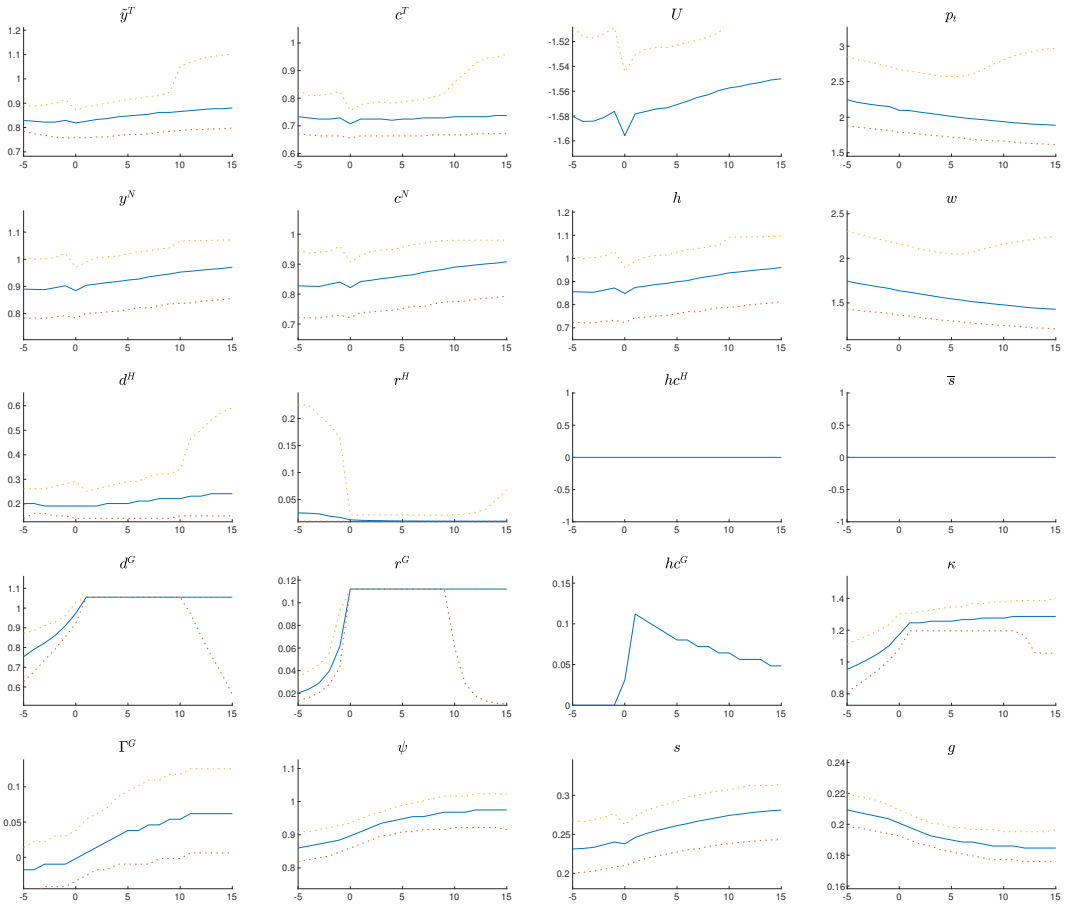


Figure 8.2: **GDEFA** - government initiated defaults with a wage rigidity and fixed exchange rates and no bailouts

Although domestic consumption improves, like with the above government default, much of this is funded from social transfers and a decline in domestic government expenditures. The net effect is a dramatic decline in utility for the household into an almost Keynesian subsistence state.

The escalating prices of domestic goods does increase output though increasing labour hours after the crisis event. However, the return to pre-crisis levels is greater than 15 periods, indicating a slow stagnant economy. This can be liked to many of the south east Asian countries that we discuss in Chapter 1, where recovery was long and slow. The important difference between this model with separate public and private debt, and the more traditional mainstream models is that is clearly illustrates the *different* dynamics between public and private debt in a crisis. The core driver to many crises is in the private sector rather than from the government. Moreover, with the elevation of private sector defaults frequency of leading to a public sector default with pegged exchange rates and downward rigidity we clearly model a protypical small developing economy where a quasi sanctions by foreign investors prevent them borrowing in their own currency and that they have to trade domestically using US Dollars. Although a government may have a floating currency, the inability to borrow in own currency limits the ability of the country to respond to a crisis without incurring another form of sanctions, namely Austerity measures, from NGO's such as the IMF and World Bank (or in the case of Greece The ECB and

EU commission) (Blyth, 2013).

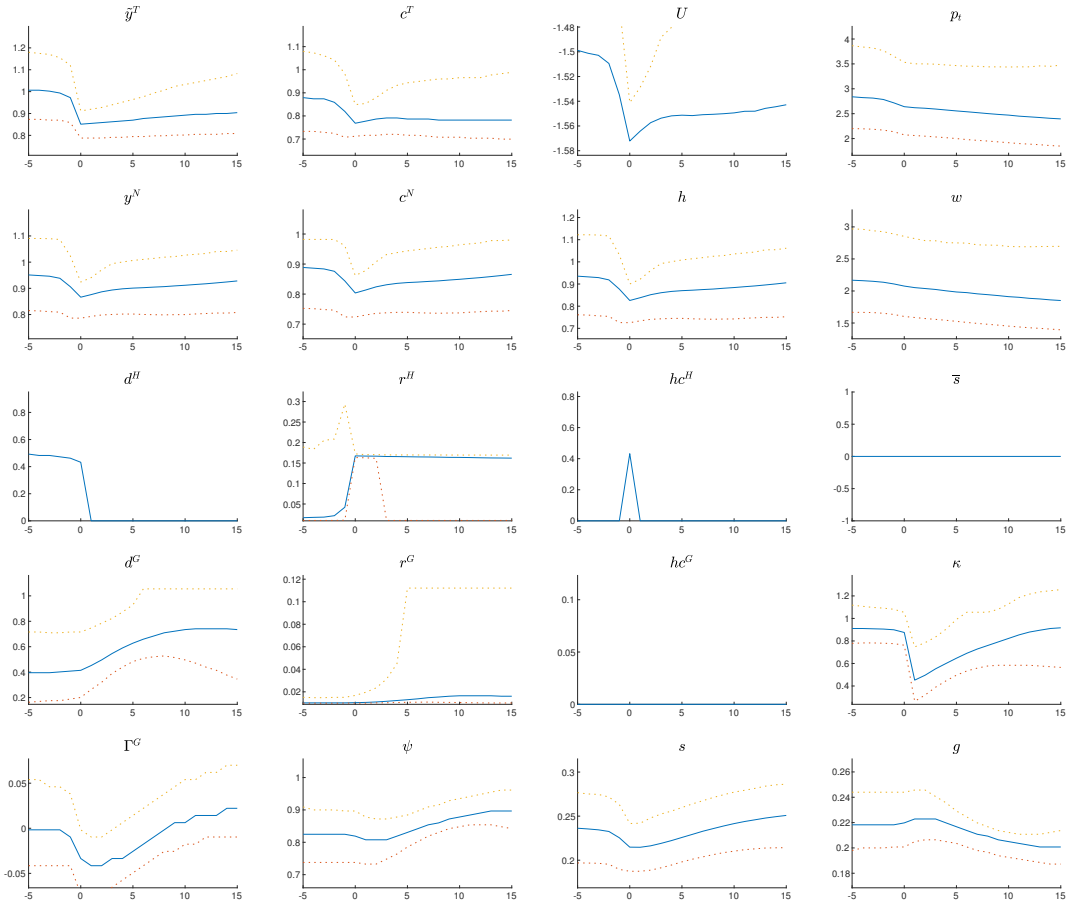


Figure 8.3: **HDNBA** - household initiated defaults with a wage rigidity and fixed exchange rates and no bailouts

8.2.2.2 Wage Rigidity with Bailout from the Government

In our frequency analysis we identify that bailout with a wage rigidity and pegged foreign exchange has a marked positive effect on governments not getting into a public sector crisis. This runs counter to many of the theoretical papers with support for this found in Guajardo, Leigh and Pescatori (2014) that states many papers overstate the expansionary nature of austerity, further Guajardo, Leigh and Pescatori (2014) claims austerity has long term detrimental effects to both the economy and the people. One may question why the pill of austerity for the Greek economy post 2012 and the economic and social decline that is likely to be intergenerational is any better than attempting to refloat the economy with expansionary measures and cleaning up the debt with haircuts. One aspect of the US policy post 1945 was to create expansion of crippled economies from WW2 rather than making them pay for the damage caused. We contend that externally or ideologically imposed austerity is a form of discipline device on a country or a people. Indirectly foreign investors bail out the private sector by lending to the government sufficient funds. As we have already discussed, default is not always necessary and renegotiating debt with an expansion may be a better alternative. Therefore with this

wage rigidity and fx pegging, we can demonstrate the difference between not bailing, effectively government imposing austerity measure on the private sector and bailing out, a form of expansionary policy.

Here we introduce the scenario of bailout with rigidity showing the marked difference to that of no bailout that we illustrate in the time path Figure 8.4. The important difference is the recovery of both tradable and non-tradable consumption immediately after the successful bailout event. With that, there is a short period of unemployment h and wages exhibit the same gradual decline, however to a lesser extent. An interesting point is that with the bailout $\bar{s}$ private debt is settled and then recovers a little, however not to the prior to crisis levels. Interest rates on private debt do not remain a block to households acquiring new debt. Moving to the government, there is a great deal of similarities in the primary surplus, debt profile and fiscal policy rule, however, social transfer are affected by the fall in domestic tax revenue then there is a equivalent fall in domestic transfers. This is a facet of the model, where domestic social transfers are the residual from government expenditures. With this scenario, utility drops and recovers quickly when compared with a no-bailout. A side by side comparison of flexible and wage rigidity in both bailout and non-bailout for a private crises is in Figure 8.5.

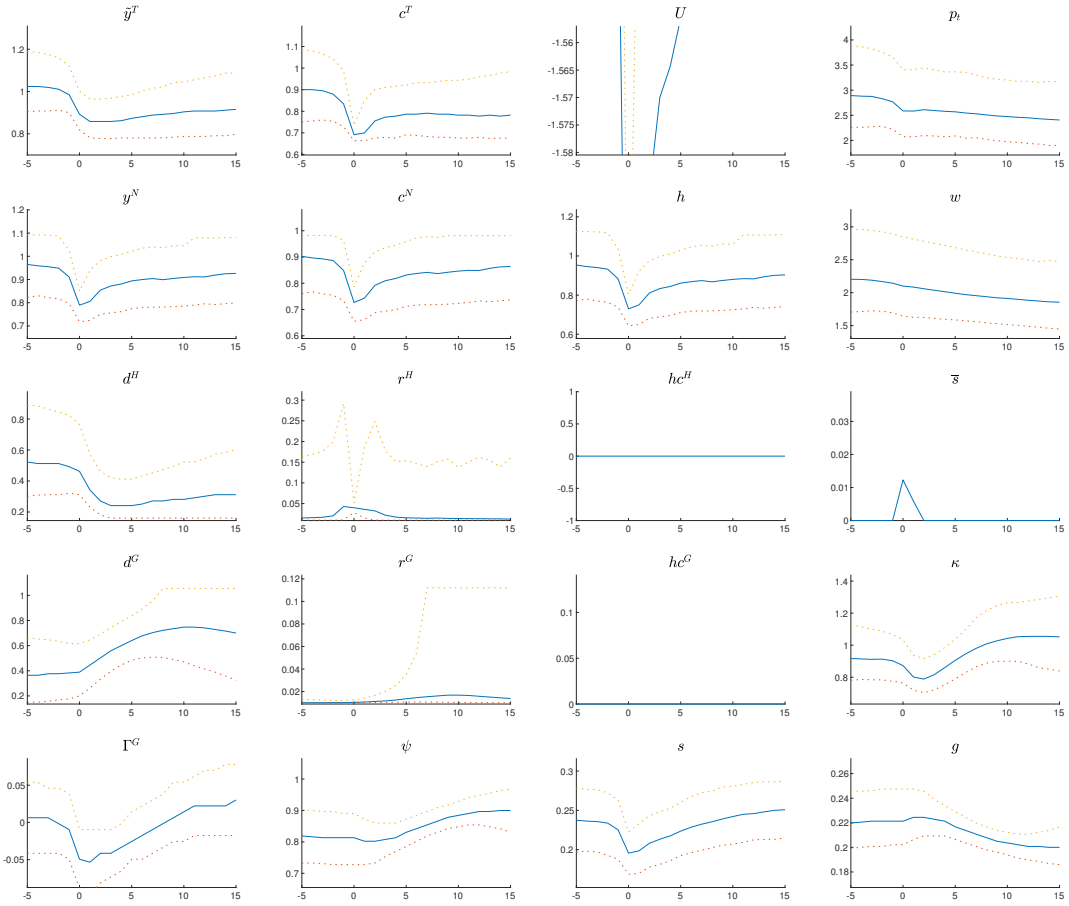
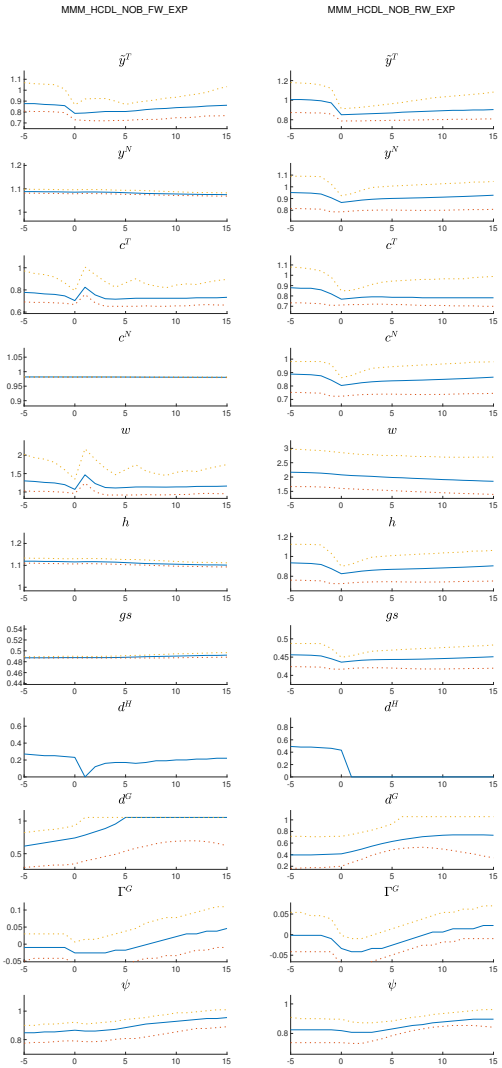


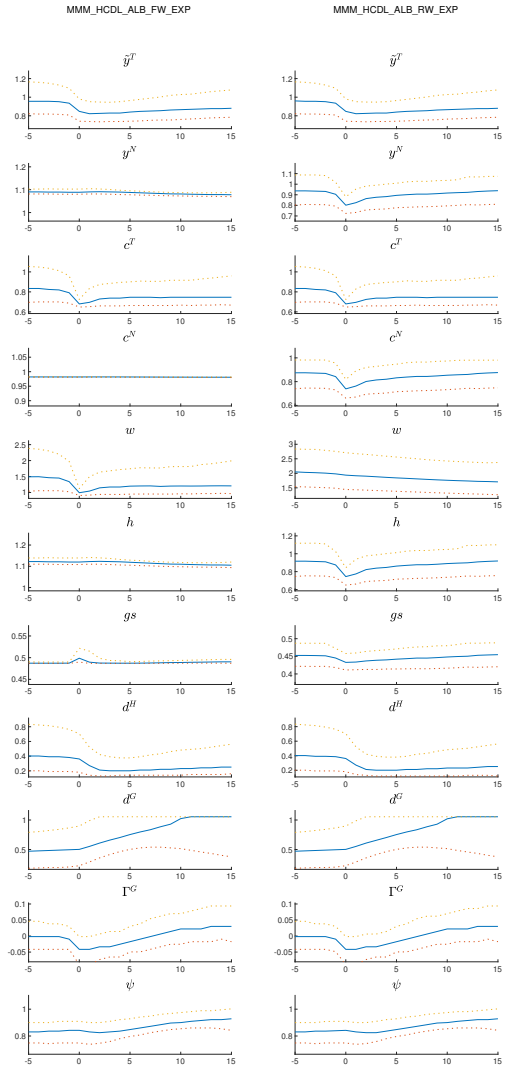
Figure 8.4: **BAILS** - Successful Bailout by government with a wage rigidity and fixed exchange rates

In the side by side comparison Figure 8.5, the columns to the left of each sub figure are the foundation (no bailout) and foundation with bailout, and the columns to the right are wage

rigidity scenarios. Only the foundation scenario has up tick in tradable consumption that affects real wages. One aspect of the rigidity is that the disturbances that occur in real wages are now transferred into domestic labour, income and consumption. In both bailout and non bailout, wages are typically higher for a wage rigidity at the start of the sequence, as the downward pressure we see in flexible wages is being constrained. Note also that only the foundation model is running a primary deficit prior to the crisis; in all other scenarios the primary deficit is small and insignificant. However, the rigidity imposes quite a significant deficit, not unexpected in the case of a bailout, until the fiscal policy rule increases; therefore increasing tax rates and decreasing government expenditures in response to rising public debt. One aspect common to the bailout in either flexible or rigid wage regimes is that private debt remains low post crisis, the deleveraging that occurs is largely from the government subsidy and prevents the rebounding that we see in consumption for the foundation scenario.



(a) No Bailout with flexible (left) and wage rigidity(right)



(b) Bailout with flexible (left) and wage rigidity(right)

Figure 8.5: Comparison between no bailout and bailout with flexible and wage rigidity

8.2.3 Wage Rigidity - Summary and Conclusion

We can observe that the model shows a marked difference between a flexible wage regime and a wage rigidity with pegged fx when comparing with a bailout. Government bailing out the private sector has two main implications, first, government is less likely to default as a result of bailing out when compared to adopting the no-bailout. Second, the economy recovers quickly and there is no long tail akin to the Keynesian subsistence state. One aspect of a wage rigidity is that real wages decline and it induces unemployment at the crisis point. Neither bailing out or not has any real effect on the sudden drop in employment however, bailout does tend to reduce the impact in the domestic sector. There is a less pronounced decline. From the foreign investor's point of view, government bailing out the private sector means that the private sector deleverages by retiring debt rather than defaulting on it. Therefore, a foreign investor is likely to support the government in such a move as they reduce their own losses. This argument and model supports the view that even if a country has a pegged currency or that most of the business is in a foreign currency, then governments stepping in a resolving the private debt crisis is a much better outcome for all sectors. Although we have not tested austerity directly, the foundation model settings in fiscal policy imply that government will increase tax revenues and decrease expenditures to reduce the primary deficit.

8.3 Fiscal Policy and Realisation

We conduct the next exercise in exploring economic stability and crises with a thought experiment which we realise though our implementation of the model. Normatively, tax rates and government expenditures in many models are either fixed or a smooth monotonic function of some government policy monitoring as in Cantore et al. (2017). In the foundation model, we have a fiscal policy rule that derives from three factors: that of consistency or persistence of policy, national tradable income, and level of government debt in the form of a Taylor type rule. Further discussion on this is in Chapter 3 and Chapter 5 where we explore the effects of changing those fiscal policy parameters on the stability and response to crises. To this point, we employ what we term a fiscal expansion realisation: tax rates for consumption and income are linear increasing function the fiscal policy rule, and government expenditures and tradable social transfers are decreasing functions. We already demonstrate that what could be deemed as an expansionary policy could easily turned into a austerity policy if one focuses on government debt. Therefore, the policy parameters for the fiscal policy rule and the fiscal realisation are closely bound and need fine tuning to the specific country setting.

Rather than limit ourselves to just one fiscal policy setting, the implementation of the model allows us to using *any* function, continuous or not, monotonic or not, step, flat or anything that can be coded into a grid that gives values for tax rates, government tradable and domestic expenditures and social transfers transfers independently of each other. The consequence of this flexibility is that it is quite easy to create fiscal ideologies that match government behaviours much more closely. For example, consumption taxes, normally in the form of a VAT (Europe), GST (Australia and New Zealand) are applied to a range of goods and services with differential

rates for those products and services. However, governments are loathed to change the consumption tax rates unless there are extreme circumstances, therefore they tend not to respond to small incremental policy rule variable changes, rather, the act step wise. For example, the UK has had VAT at 0%, 5% 7.5%, 10%, 15%, 17.5%, 20% and 25% and is applied selectively at different rates to different goods[8]. Likewise New Zealand has had GST at 0%, 7.5%, 10%, 12.5% and 15%, however it tends to be universally applied to all goods and services except financial transactions[9]. If we assume that a basket of consumer goods is likely to remain proportionally quite constant, then the calculation of realisable tax rates for consumption is possible as D'Erasmo and Mendoza (2016b).

Our current fiscal policy realisation indicate tax rates are increasing in income and public debt, and social transfers with government expenditures are declining though the fiscal policy rule. This is a form of automatic stabiliser that acts counter-cyclically to revenue. However, this is not always the case. The recent UK government announcements in June 2020 and subsequent announcements show that policy responses may NOT conform to a countercyclical stability regime; rather, a short term measure to address select sectors in the economy in the face of mounting public debt levels. Moreover, the worker furlough schemes are countercyclical in both income and debt; this is a significant 'bailout' of the private sector in the face of a crisis. There are many other examples where government response to a crisis may not be initially counter-cyclical, therefore relaxing the assumptions that we make in our initial mildly expansionary stability realisation to test out other combinations so as to demonstrate the flexibility of both the model and its implementation though the scenario mechanisms.

8.3.1 Changes to the Model and Scenario Operation

One aspect of this model is that all of the tax rates, government expenditures and social transfers are coded into grid points in their own tables that relate to the fiscal policy rule. We discuss how the fiscal policy rule responds to income and public debt accounting for consistency in Chapter 5. We note already that our policy experiments can turn a mildly expansionary fiscal realisation into an austerity policy by focusing principally of public debt. Our initial experiment is to have two settings for each tax schedule: government expenditures and tradable social transfers. Effectively, the second setting of the schedules is the reverse process. For example, if $\tau^C\psi_1 = \tau^C_1$ through to $\tau^C\psi_{200} = \tau^C_{200}$ in our current policy setting, then the reverse is $\tau^C\psi_1 = \tau^C_{200}$ through to $\tau^C\psi_{200} = \tau^C_1$. Just by using this provides for 25 different fiscal ideologies that we can draw into any combination of consumption, income, government expenditures and social transfers.

For this experiment we chose five representative ideologies that could either stabilise or destabilise the economy. We illustrate the relationship tax and expenditures to the fiscal rule instrument

[8] As at January 2020, VAT is 0% for most food items, 5% for home fuels/electricity, 20% for all other goods and services except for financial transactions and second-hand goods. Stamp duty on property is a questionable if it is a consumption tax

[9] NZ current rate is 15% on all items including unusually food. This is questionably quite regressive considering the nature of foodstuffs consumption

Code	Description	τ^C	τ^Y	g^T	g^N	s^T	Noted Stability
EXP	Downturn - Expansionary policies	Pro	Pro	cntr	cntr	cntr	Very stable in most cases as it tends to generate low levels of government debt
SOC	Downturn - Expansionary policies	Pro	Pro	Pro	Pro	cntr	Tends to be unstable in government as there is a mismatch in tax revenues to the expenditures.
CON	Downturn reduce tax and decrease both government expenditures/social transfers,	Pro	Pro	Pro	Pro	Pro	Tends to generate a level of instability, very quickly reaches a tipping point.
AUS	Downturn - Increase taxes, increase expenditures	cntr	cntr	cntr	cntr	cntr	Again tends to be unstable.
EAU	Downturn - Increase tax and decrease both govt expenditure and transfers	cntr	cntr	Pro	Pro	Pro	This causes the government debt be very unstable.

Table 8.3: Experimental fiscal Realisations. EXP is the foundation realisation. Under The columns under the fiscal variables τ^C though to s^T indicate the classicality with the fiscal policy rule. This fiscal policy rule is pro-cyclical in both public debt and tradable income.

for the five policies in table Table 8.3. These combinations provide a wide perspective over the possible fiscal ideologies currently set up in the model's implementation. However, further experimentation may render other stable combinations from this base set of schedules.

The technical implementation means that for every fiscal policy realisation, we need to redo the policy rules and structured data, as well as recalculate the domestic optimization for both flexible and wage rigidity. Of course, this work can be paralleled. Once the optimization and policy rules are set, then use simulations in the way we describe in Chapter 4 to form the basis for analysis. Additional fiscal ideologies which require different coding for the two experimental schedules per variable are a simple addition and then any combination of realisation for tax and expenditures can be set up in the configuration data. In this way, many different policy experiments can be run to contrast and compare outcomes.

8.3.2 Simulation Results

Use the foundation scenario with defaulting to the lowest level of public debt as the basis for our analysis. Unfortunately, default to the NDL (Natural Debt Limit) creates very unstable results in some of the scenarios[10]. Although our analysis of default to different levels indicates that defaulting to the lowest level create some volatility, it does give the opportunity for the least stable fiscal ideologies to achieve some form of stability. Figure 8.5 provides a breakdown of the five scenarios that cover the different ideologies. Not entirely unexpected, the non

[10]In a couple of cases, the lack of fiscal stabilisers causes continuous public debt defaulting, trapping the economy in an unstable state.

foundational scenarios demonstrate a much higher degree of instability in public debt, namely, public debt defaults (**GDEFA** occur an order of magnitude greater than the foundation. An interesting point here is the effect on private sector debt **(NDNBA**) in that all of the alternative ideologies reduce private sector initiated defaults however, increase the possibility of a private sector default after a public sector default (**GDEFx.GDHDx** and **GDEFx.HDNBx**, that is household and government default, and household default respectively). What seems to happen is that if either default then it is likely to trigger the other into default. This is particularly apparent in ideologies **CON**, **AUS** and **EAU**. We now look at the time paths for public sector default, **GDEFA** Figure 8.7 and private sector default **HDNBA** Figure 8.6.

Event	Default Description	EXP	SOC	CON	AUS	EAU
ALLxx	all events	36815	123340	108200	193090	125550
GDEFA	All bailout good or bad	12939	102630	101490	177510	122330
GDEFx	First attempt failed bailouts	12311	72979	46696	93244	59532
GDEFx.GDHDx	Successful bailout	230	27699	53514	80881	60728
GDEFx.HDNBx	Bailout followed by Govt default	398	1948	1283	3384	2071
HDNBA	ALl government defaults	23876	20711	6704	15585	3221
HDNBx	Household default, no bailout	21949	9082	37	3808	0
HDNBx.GDEFx	Household default followed by government default	1714	9755	514	9748	145
HDNBx.HDGDx	Household default followed by household and government default	0	0	4713	0	1963
HDNBx.HD˜+GD		213	1874	1440	2029	1113

Table 8.5: A comparison of fiscal realisation impact on event sequence frequencies.

Starting with public sector defaults (**GDEFA**), it becomes immediately apparent that both **CON** and **EAU** are generating cyclical behaviours with a periodicity of 15-18 periods and 6-8 periods respectively. In some way this is an interaction between the fiscal rule's possibly over responding to income and public debt and reflecting that into tax rates and government expenditures. In the case of **EAU**, this materially impacts tradable consumption c^T with a number of steps downwards as each cycle affects the household. In both these cases private debt d^Hcollapse at the crisis point and do not recover within 15 periods as does labour wage wh. Effectively, these two scenarios generate a low state in the economy similar to that of what Keynes argues in Keynes (1936).

As we commented in Chapter 7, part of this instability generating mechanism is the government defaulting to the lowest level of debt, this then drives down the fiscal rule instrument. Both these scenarios share government expenses (s^T, g^N, g^T)which are pro-cyclical with the fiscal rule instrument. Characteristically, the residual term s^N has a counter-cyclical relationship with domestic government expenditure in **EAU** and a pro-cyclical relationship in **CON**. We can explain this though the difference in tax schedules in that **CON** is pro-cyclical in tax and **EAU** is counter-cyclical. In **SOC** we observe a rippling effect into the domestic labour wage

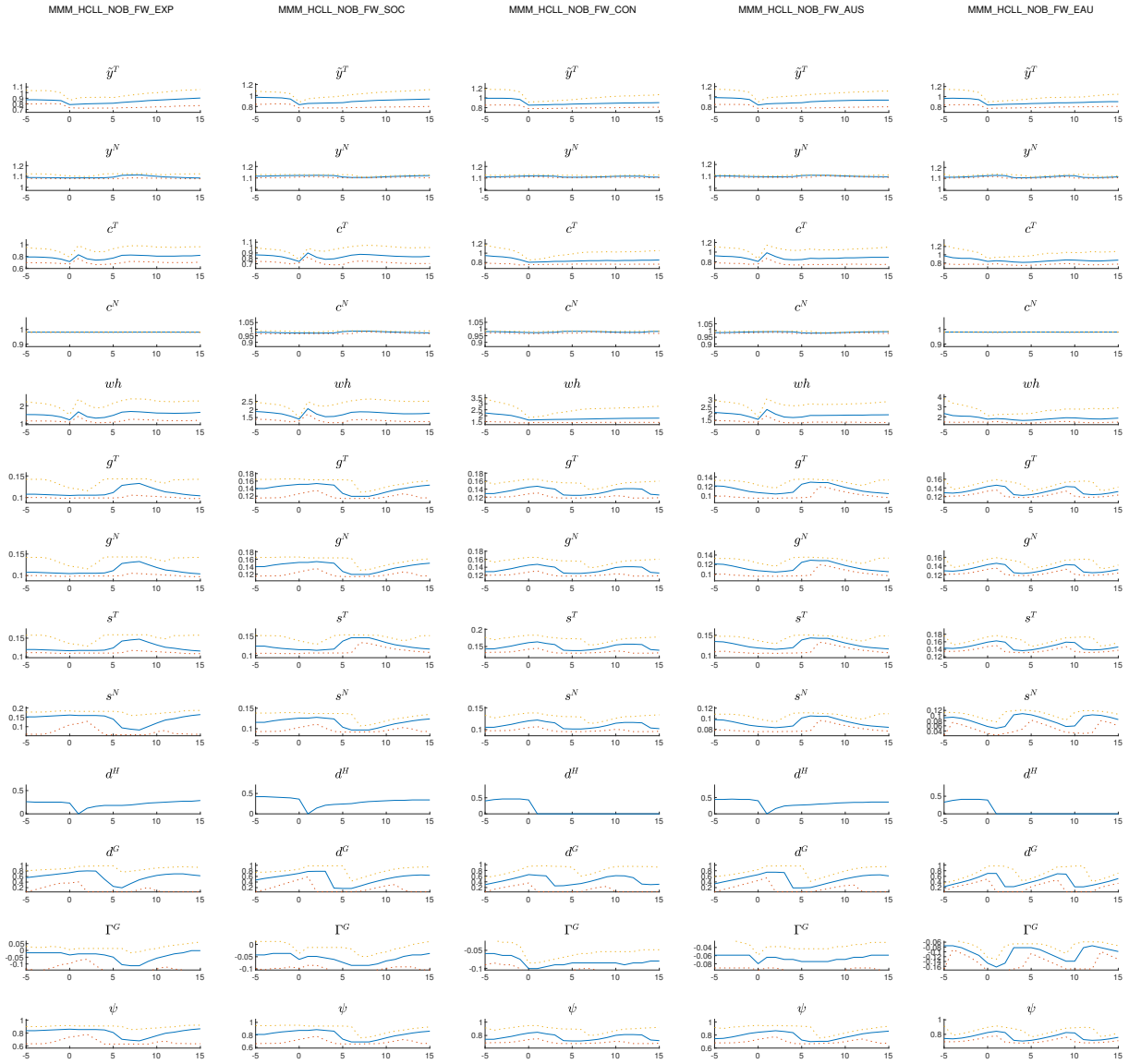


Figure 8.6: Household initiated Defaults with no bailout. Comparison of fiscal realisation scenarios default to the lowest level of public debt (HCLL). From left to right Expansionary, Social, Conservative, Austerity and Extreme

paralleling that of tradable consumption. This implies that the differential price p between tradable and non-tradable is transmitting the tradable economy's fluctuations into the non-tradable. Note that tradable income y^Thas a double dip recession and the second recession is only mitigated by the government increasing tradable social transfers s^T in deference to the domestic transfers. One could conjecture that maybe higher reference tax rates τ^C and τ^Yin these cases might provide for greater stability. This we will leave for future experimentation.

Next, to consider a private sector default (**HDNBA**) in Figure 8.6. In this case, on **EAU** demonstrate continuing instability with a periodicity of about seven periods. Effectively, government is unable to stabilize the primary surplus Γ^G generating wide swings in public debt. We do not observe this with the other fiscal ideological scenarios analysed here. As with Public debt, **CON** and **EAU** experience a a significant deleveraging; however, this is by defaulting and what

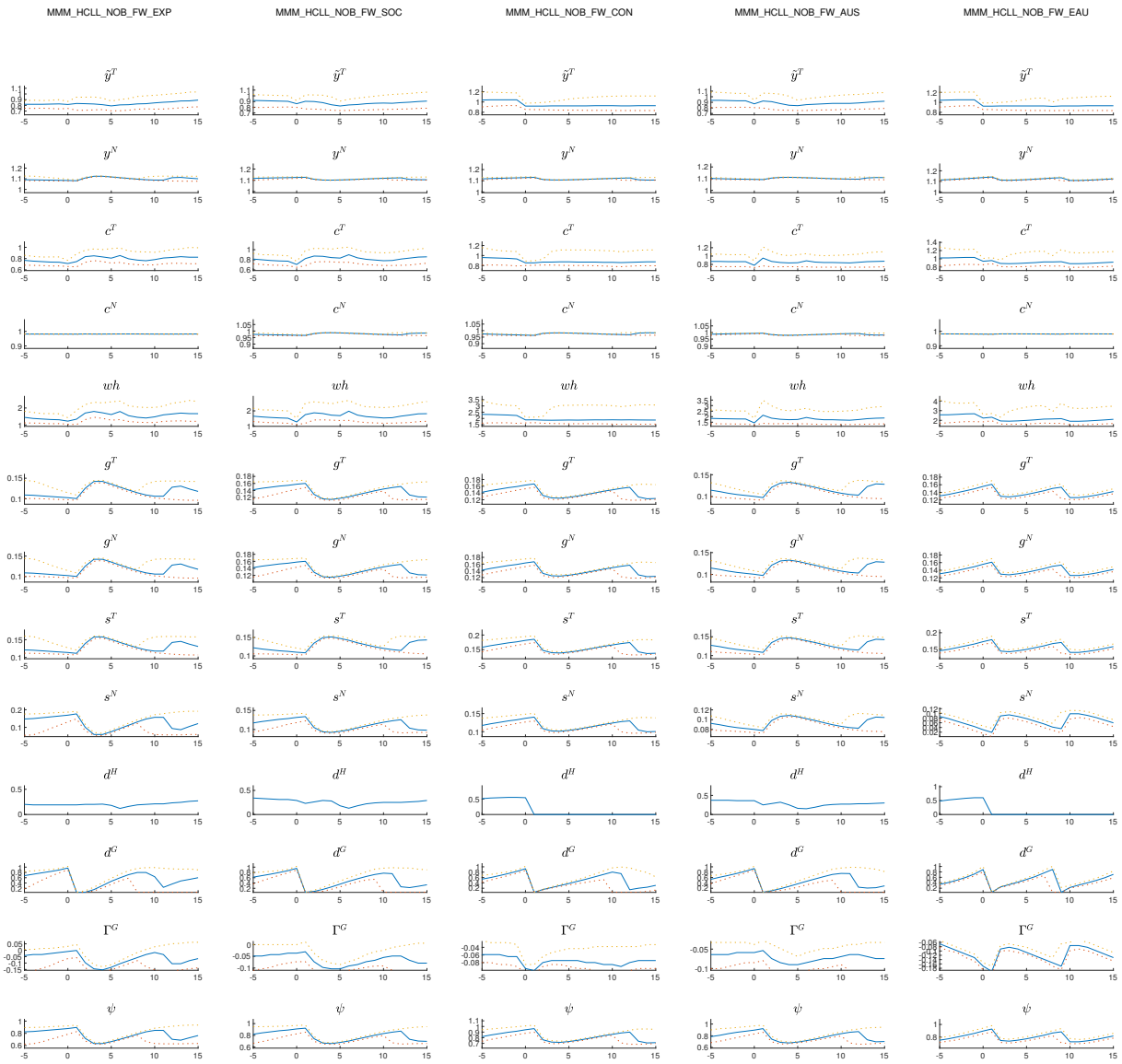


Figure 8.7: Government initiated Defaults with no bailout. Comparison of fiscal realisation scenarios default to the lowest level of public debt (**HCLL**). From left to right Expansionary, Social, Conservative, Austerity and Extreme

follows is a long period of no access to debt. Deeper inspection indicates that the household is stuck in a low ebb state until the economy y^Trecovers sufficiently under sanctions to lift it out of poverty. One aspect is that **CON** and **EAU** consumption remain flat and low without a peak after default reinforcing the argument that they are stuck in this Keynesian low state. Even social transfers seem not to lift the economies out of this state indicating that taxation is having a suppressive effect when combined with sanctions.

8.3.3 Fiscal Realisations - Summary and Conclusion

Although we cover four more scenarios which reflect alternative fiscal ideologies, this is only a preliminary investigation into how a fiscal policy rule and fiscal realisation can create both stability and instability. Furthermore, the implementation of the model allows for a number of

different taxation policies and government expenditure strategies, which are possibly more reflective of the real world where governments make step changes to rates and do not necessarily follow a continuous monotonic profile. An interesting part of this exercise is that model configuration can generate cyclical behaviours, albeit of a shortish periodicity; however, with some development in the parameter settings, inspecting and calibrating the fiscal policy rule, tax and expenditure functions then it should be quite possible to generate a business cycle with a periodicity somewhat approximate to that of what we observe. Furthermore, by calibrating the persistence/consistency parameter in the fiscal policy rule, then it is possible to generate long wave hysteresis. We have already shown that we can create a double or triple dip recession in either tradable or non-tradable sectors or both.

This extension to the model and its implementation goes far beyond that of much of the literature and is an opportunity for further experimentation, calibration and configuration in an attempt to replicate real world crisis episodes.

Chapter 9

Summary, Discussion and Conclusion

9.1 Summary

Going back to the original question in Chapter 1:

> Is it possible to create a flexible parsimonious macroeconomic computer simulation model that can illustrate the frequency, types and time-paths of various financial crises in an open economy with credit restrictions?

And then breaking it down into its component parts. First is a parsimonious macroeconomic computer simulation? In answer, we can say that the underlying source macroeconomic model is parsimonious and seminal using Eaton, Gersovitz and Stiglitz (1986) with modifications by Schmitt-Grohé and Uribe (2016a). The extensions include , using a fiscal policy rule (Cantore et al., 2017) to drive variable tax, social transfers and government expenditures and the separation of private and public debt and its defaulting. By us separating public and private debt we introduced a number of government bailout strategies, government debt default strategies and haircutting policies. With the fiscal policy rule we introduce dynamic budgetary process and the ability to set different fiscal policy realisations though taxation, social transfers and government expenditures. The model uses the idea of policy scenarios to construct the possible combinations of parameters and strategies into meaningful calibratable replications of real economies.

The second part is can system illustrate frequency, type and time-paths for crises? We demonstrate throughout this work a wide range of simulations that show all of the information in a comprehensible form. Moreover, we have a range of heuristic learning tools that analyse simulations looking for crises sequences and then automatically classifies them. We then compared a number of different classification of crises with real world data noting that the underlying strategies in the real world are largely hidden. We show that we can replicate both private and public debt crises paths.

Finally, to add to the answer, the suite that underpins the model has currently coded over 11,500 possible scenarios. We show that the flexibility of model by pushing the limits of the

calibrations to identify areas of weakness and its ability to cover open economies. The only next step would be to calibrate the model to the middle and low income countries and scenario test the model's veracity against the real examples. An important aspect is that crises are infrequent in many cases and investigation into the political thinking at the time is normally clouded with rhetoric. This we will leave for future development and research.

Now we have shown that a suite of models that can represent crises scenarios for a open economy, its now important to reflect on the discussion in the first chapter. We took a pluralistic approach to analysis, interpretation, and conclusions looking at the different economic schools for theories and practical examples that may explain some of the outcomes. Moreover, we draw on both narrational and empirical historical analysis to identify the strategies, policies and actions governments, the private sector, foreign investor and NGO's take when addressing a crises. Combining the different economic schools, the historical aspects with the more traditional neoclassical theory tends to provide a clearer understanding of these most difficult times for countries and their people.

Drawing back to the quote that started this work and the context that it provides for both historical and recent events, we need to look at the role of economic actors in the wider context of political power. For some, crises are an opportunity to gain wealth and power, for others they are a source of misery. This leads us into our discussion.

9.2 Discussion

The following sections cover the important issue of Role of Government and Economic Actors, Why governments intervene, what do the identify and what do they do and how they target the intervention funds at. Finally we discuss why forecasting the timing, scope and depth of crisis means that the economy is normally unprepared for a crisis and they response tends to be emergency measures.

9.2.1 Why intervene? The Political Goals and Motivations

History may give some guidance on government policy on intervention or not as the case may be, and the mechanisms. Finding a economic theoretical basis to determine the reasoning and motivation from economics without considering the socio-political motivations as well would fall somewhat short of justifiable hypothesis. Starting with the political reasoning, consider the power differential between the financial institutions and the government. Over a period of time leading up to the 2008 crisis there was a significant consolidation providing them with structural power in the relationship (Culpepper and Reinke, 2014). First, this meant that the focus was on financial institutional bailouts, and not necessarily the rest of the economy, second, the power dynamic worked differently in the UK and the US. In 2008, the threat of systemic collapse was imminent, however, in both cases the regulator/government did not exercise its power the take control by appointing commissioners of the functioning system part of the

financial institutions[1], rather it chose to inject a combination of capital and liquidity into the institutions.

In the US, Congress railed against any public ownership or control only accepting a equity injection into AIG to settle CDS liabilities as this was the primary source of mark-to-market write-downs. In the UK where the government did not necessarily have the structural power, they participation was voluntary and only participants where the highest risk with risk based fees. As at 2016, the government still is in a loss position with the bailouts. In the US all institutions, good or bad had to participate and a system or warrants ensured government got is money back, the government has a net gain in the bailouts.

One characteristic common to both, shareholders retained their equity and if they waited until the financial institutions had recovered, then regained all their losses. In the UK case, Government lost and shareholders gained (they did not loose the investment). The US, both government and shareholders made gains, however at the expense of future investors. The US financial institution's framing was that if they failed, that the real economy would be directly affected though transactional banking. This is a significant consequence on the real economy if it really occurs(Strahan, 2013). It is somewhat difficult to determine a direct motivation, however some factors include, political donations from the 'shareholding' class, the framing that some financial institutions are too big to fail and the framing that the consequences are 'unimaginable'. As the voting public do not have the direct influence that lobbying Corporations and 'shareholding' class has, the bias in motivation would be towards bailing financial institutions to protect investors. A by-product is that the transactional part continues. We have the possible set of motivators and the the reasoning to intervene.

Keynes focus would not necessarily be on the side of bailing out financial institutions. Rather, the Keynesian directs effort to the household and protecting the household by boosting their suppressed consumption creating effective demand. Nevertheless, one needs to consider in the modern economy the almost total reliance on financial institutions to provide the transaction infrastructure. This presents the government with a conundrum, does it protect the household or does it ensure the transactional infrastructure continues. Many present this as mutually exclusive, however they are not. If the government has sufficient resources and the political will then it can protect all. However, even in the 2020 pandemic, countries such as the US have not had that political will to protect the household, rather they put most of the relief into large corporates. Money power reflects in political power that determines who wins and who loses in a crisis.

9.2.2 Who do you protect? Competing ideologies

Once a crisis is upon a country, the government needs to decide what response. In the foundation scenario, the government only applies the fiscal rules and ideology whereas we observe government intervention going beyond some formulaic tactic, rather taking a much more aggressive intervention by transferring wealth from the government to the private sector to either

[1]There was one case, in the UK, Bradford and Bingley, government took control of the functioning transactional part with deposits

prevent or mitigate the crisis. We have already discussed in the motivation who is the intended recipient of the intervention and the recipient that benefited from invention.

Many government proclaim that their policies are to benefit the people, however we dispute this, rather government intervention tends to benefit firms and the select few of high value investors with significant wealth transference from the lower two quartiles to the 1% Young, Banerjee and Schwartz (2020). Fundamental question is, who is the government trying to protect? If is uses a supply side ideology, then it is more likely to be motivated by calls from FI and corporates whereas a demand side ideology is more likely to focus on a household and consumer difficulties. A cynical view is that government will only intervene if its power in the current term or ability to be re-elected is compromised. Alternatively, the case of 1933 Germany it was an excuse to concentrate of power in a single party. We can observe today in the US the 2020 crisis response motivation is more that of concentrating power in the donors and their supporting political actors, thus shifting the political spectrum towards corporatism (Young, Banerjee and Schwartz, 2020).

The US 1929 crash and the following fallout from policy by Hoover administration , it was clear by 1932 where the impacts were and the bleak outlook, the role of austerity and classical economic think was tested and failed (Skidelsky, 2018). Effectively, the US economy was close to a subsistence level as Keynes hypotheses in The General Theory (Keynes, 1936). With increasing civil unrest (something Keynes was always trying to avoid) similar to that of Germany in the 1920's & 30's could authoritarianism take old? Enter the New Deal.

The 1933 New Deal was clearly aimed at addressing the rank depravation from both the 1929 crash and the drought that the mid west America was experiencing(Kennedy, 2009). The causes are a point of contention with claims that poor monetary policy, labour wage being that brought about the crash. However, the consequences are well understood with the longest period of depravation in US history and rippling to other economies including the Germany where it had disastrous political consequences. The expansionism of the New Deal (and similar, however for different purposes, expansionism in Germany under the NAZI regime) with the imposition of substantial regulation on the financial infrastructure decreased unemployment by 50% in 18 months and the US economy started to expand. Only the fiscal conservatism of 1936/7 did the economy contract until WW2. The government created effective demand though big infrastructure and many other projects whilst improving worker outcomes. Although firms profited from the New Deal, they did not do so necessarily at the expense of the working and middle class unlike the 2008 and 2020 crises (Jeffries, 1990).

There is significant criticism of the response and follow up to the 2008 crisis as many contend that the government intervention focused on bailing out those that were the major contributors to the crisis with little recourse to those that caused the crisis. This is seen as more egregious in the case of the UK, that followed was a period of austerity supposedly motivated by the notion that public debt levels pose a problem to the government Skidelsky (2018). The events surrounding 2007/8 crises, although similar in the causal institutions, had very different responses by government to the crisis. Furthermore, the impact of the crisis was more direct with much of the population dependent for their daily transactions on the financial infrastruc-

ture.

When the fear of a financial system freeze, largely though a lack of trust leading to liquidity not being distributed to those that needed it and the collapse of financial institution's balance sheets. The immediacy of the problem resulted in the intervention initially that stopped insolvency, then attempted to get the financial institutions to extend credit though liquidity transformation commonly known as QE. There are a number of issues with this approach, firstly, it creates a moral hazard in the face of a scant regulatory environment that was significantly degraded from the 1980's onwards. The complete lack of enforcement of regulation throughout Europe, UK and the USA with reinforcement by punishments for those organisations and people that break them.

This is unlike Iceland where those that perpetrated fraud and mismanagement were fined and imprisoned. Effectively, the government targetted the least vulnerable by injecting and preventing financial institutions going into administration whilst offering very little to those most affected (Skidelsky, 2018). Effectively, the government reduced the risk to investors in those institutions, thus bailing out those with wealth. As to QE as a mechanism to bailout the corporate sector, this inflates the equity and corporate bond market whilst not addressing the fundamental issues of a lack of funds in the the consumers hands (Shah et al., 2019). The net effect of continued QE is to suppress bond yields that many pension funds rely on as a 'safe' asset, hence a wealth transference to those that hold equity (Young, Banerjee and Schwartz, 2020; Kaymak, Leung and Poschke, 2020). In the UK, the 2010 policy changes in government also contribute to this wealth transference with average UK household debt increasing and net wealth remaining largely for the lower two quartiles of the population.

Example policy responses include 2010 UK budget that sought to resolve public debt at the expense of social services, the IMF/ECB/Commission imposition on Greece in 2010, the lack of response by the ECB during the financial crisis and such policies dating back to the New Zealand Government in 1992. Furthermore, motivating tax cutting regimes as a form of stimulus to the economy relying on a trickle down effect' which was the mantra of Thatcher, Regan and Trump, and with tacit support in learned economic text such as Elmendorf and Gregory Mankiw (1999). These economist continue to imply taxation causes a dead-weight loss and government debt is problematic to the economy relies largely on a homogeneous household agent (Stiglitz, 2018).

What often is the cause of policy misspecification is a lack of appreciation of the affects of particular assumptions. Furthermore, well known is that a representative agent may not scale all agents that it represents (Sonnenschein, 1972) where income, consumption and savings habits across the wealth spectrum can be very different. Economists that continue to portray their beautiful mathematical models as some policy panacea without considering the assumptions and social implications not only contribute to wealth concentration, they also complicit in the consolidation of power (DeMartino, McCloskey and Nelson, 2014). Political history has taught us that continuing down this style economic pathway is likely to result in civil unrest and possibly regime change, sometimes with dangerous consequences. Therefore, any government intervention needs to address the problem of the people and not the problem of the wealthy

few.

On the one hand, we have the neo-liberal, neoclassical socio-political economic ideology, on the other the more socially constructive and societal cohesive socio-political economic ideology. One could characterise the former as self serving individualism and the other as a form of collectivism. Next to discuss the role of government and economic actors.

9.2.3 Role of Government and Economic Actors - Opinion

> "The fact that an opinion has been widely held is no evidence whatever that it is not utterly absurd; indeed in view of the silliness of the majority of mankind, a widely spread belief is more likely to be foolish than sensible." - *Bertand Russell, Marriage and Morals*

In recent times, government has sought, in the private sector, to prevent or limit the damage from a crisis which raises some policy and ideological conundrums. A fundamental question that frames the way that we think about this intervention discussion is what is the role of government and what role has economics had on influencing government policy?

In many legal and political texts, there is much debate over the role of government, in contrast, most macro-economics texts, government tends to be either cast as a benevolent dictator or an agent with the power to levies taxes, sets interest rates, borrows, social transfers and consumes. These leaves a troubling question, for what purpose? We turn to Snowdon and Vane (2005, p7) for some initial guidance on the literature. In summary, the different schools have widely diverse roles for government. From Keynes with a more active role for government to that of the classicals and neoclassicals where efficiency and optimality of the private sector and government role is limited.

Smith (1937) and Smith (2010) although raises many concerns over government intervention in a *Laissez-faire* whilst being the enforcing the law, arbiter of justice and defence of the nation. The Austrian school follows ideology that markets will self correct with only short term pain that is a contradistinction to that of Keynes that the free market is subject to coordination failures that lead to excessive and entrenched unemployment, eventual erosion of capital though lack of investment and a subsistence equilibrium, hence a poor nation with little hope of recovery in the medium term. Therefore, turning back to politics and constitutional matters, as Lincoln in the Gettysburg Address and the Constitution of France's fifth Republic state clearly, ' .... for the people ' and if it acts in any other role then it shall perish. Translating that back into Keynes, then one could argue that '... for the people' would imply some form of protection in times of trouble as market coordination failure cannot be attributed to every economic actor. Furthermore, the matter that concerned Lincoln and the founding fathers was that although individual freedoms need to be respected, there is an unequivocal role for government in governance goods in common for the common good, enforcing the rule of law and protections against abusive of power. Smith and Keynes would agree that regulation is a necessity to limit the effects of excessive cycles, as is enforcement, albeit the degree would be for some debate!

To use Smith's analogies, the invisible hand becomes the guiding hand and the helping hand when the the market fails.

So why have this discussion now. It is often neglected by Neoclassical economics is that its ideology limits the role of government as we illustrate above. However, we contend that without defining the role of government in both social and economic settings, then any analysis and resulting policy is, at best, misleading(Stiglitz, 2018). There is a darker side to the interpretations from classical and neoclassical worlds. At worst, such limiting roles for government provide political actors with a framing that promotes a select set of political ideologies using economics as an excuse for their actions. Whether the motivation for those political actors is in their own self interest and/or those that sway over political actors is beyond the scope of this work. Nevertheless, the last 40 years has seen a concentration in wealth in a select sector of society and disenfranchisement of those without the means to influence beyond the ballot box (Chomsky, 2017; Goda, 2018). Suffice it to say that such concentrations of wealth and their influence over political actors can determine the which group of ' ...for the people ' will benefit from any government intervention. One could conjecture that the rescue response to the 2008 financial crisis and the US government's response to the 2020 pandemic is more about concentrating wealth and power in a few rather than protecting the people.

One aspect mooted by the economics profession is that their responsibility ends at the publication of a article or paper and it is for policy makers to decide on the appropriate policy(DeMartino et al., 2014). Many academic papers attempt to draw conclusions and pass judgements on government policy recommendations. An example is Thomas Sargent's YouTube lecture entitled "Computational Challenges in Macroeconomics" where he makes claim to simple mathematical models being tools for policy. However, many of the claims ignore the underlying assumptions that make them tractable, mathematically beautiful and/or parsimonious and these can be material to the conclusions, therefore the judgements on policy. Economics is not an exercise in mathematical beauty with some contest fought out in academic journals, its value comes from the economic, hence social betterment of society. As in DeMartino, McCloskey and Stiglitz (2014) ethical economic actors need to consider the wider implications of policy recommendations and its moral implications. It is inexcusable for the economic actors to not appreciate the contexts that judgement by those in eminent influencing positions both academic and professional (Wallis, 2002). Furthermore, such lack of appreciative judgment making in the way that academic ideas, namely mathematically solvable models and parsimony, are portrayed to political actors with the glossing over core assumptions and a lack of explanation of model limitations, leads to, at best, misinformation put in the hands of policy makers. At worst, reinforcing political ideologies, particularly at the conservative end of the political spectrum, with hawkish government fiscal policy and near total reliance on monetary policy to solve macroeconomic cycles.

Regardless of motivational considerations of economic and political actors, it is plausible that a significant crisis could trigger a sequence of events akin to those leading up to significant civil unrest and move the political landscape in dangerous directions (Snyder, 2017). Therefore we contend that economic actors, particularly those that influence policy either via academic research or professional advice must be cognizant of the implications on social fabric of society.

Failure to do so is a failure by those actors to consider the ethics of policy recommendations with potentially deficient moral compass.

9.3 Conclusion

In this work, we take both an economic and political interpretation to understand and interpret crises. Why both? Macroeconomics without politics is just empty theory and politics without macroeconomics is just rhetoric. We claim that discussing one with the other is an exercise in futility. As the world stands on a precipice of potential economic and social ruin, one lesson from it is that the way that political actors think about economics is instrumental in how they respond. They gain that knowledge from academic and professional economists. In the last 40-50 years, those educational economist have come from a range of similar thinking schools that suit certain political ideologies. In some-way, we attempt to redress some of that balance by taking a typical neoclassical mainstream model and adapting it to perform in a more in line with the typical strategies employed by politicians to address crises. Making the model flexible and adaptable ensures that it could be calibrated and configured to most middle and lower income countries. We make clear the assumptions and the impact on any results from the model. As we stated at the start, we make no policy claims, just insights into how economies operate in a crisis.

As to implications from the modelling and simulation exercises herein, we have shown to some extent that governments that act in a more benevolent way to the household normally have better crisis outcomes. Moreover, and in contradiction to many of the mainstream economics literature, our modelling reflects the empirical evidence that the private sector causes twice as many crises as governments do and if government do cause a crises, it is normally as a result of a corrupted political system. For the foreign investor, we confirm some of the findings of Obstfeld et al. (2009) and the evidence from the Paris Club that it is in the interests of foreign investors to negotiate rather than attempt to enforce unenforceable contracts. In many cases we identify that foreign investors are better off continuing to fund the government accepting lower returns so the government can bailout the private sector, thus preventing economic collapse.

One aspect it is important to address and a constant theme throughout this work is *austerity*. This has been the mantra of many governments, NGO's and macro-economists in response to high levels of public debt. We show from both a historical narrative and a model derived form that austerity actually makes the situation much worse and makes the economy much more unstable. The obsession with the level of public debt by politicians and macro-economists is at best foolhardy and at worst dangerous with civil unrest and social depravation. We have seen that since the 2008 crisis, the lack-lustre socio-economic programmes and austerity policies has boosted wealth interests of the already wealthy and deprived the low wealth individuals. With wealth comes political power and that political power adopts policies in the interests of those that fund them. Where this ends up, no one knows. Nevertheless, history has a nasty habit of repeating itself.

However, it seems we do not learn the lessons of history. Although governments are better

off protecting the household with credible interventions than a more self interested or non-interventionist strategy, we still see many economists maintaining the same rhetoric of inflation, debt and belt tightening based on fictional theories of the economy. Unless academic economists explain the background and consequences to these ideologies to students then the next generation will again repeat the same mistakes. As in the Dickens at the beginning of this work, "It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity...." we academic economists have a societal responsibility to ensure that future generations are not preprogrammed with select set of ideologies but, are able to learn from history to make better judgements in both policy making and business choices. Hopefully this work contributes to that ideal.

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Appendix A

Fiscal policy rule

Rule	ρ_{ψ}	$\rho_{\psi y}$	$\rho_{\psi d}$	ψ_{min}	ψ_{av}	ψ_{set}	ψ_{max}
MMM	0.6252	0.1478	0.0777	0.39277	0.80341	0.9	1.3659
MML	0.6252	0.1478	0.03885	0.43258	0.80553	0.9	1.3255
MMV	0.6252	0.1478	0.1554	0.32381	0.80111	0.9	1.4504
MLM	0.6252	0.0739	0.0777	0.40538	0.80301	0.9	1.3234
MLL	0.6252	0.0739	0.03885	0.44647	0.80513	0.9	1.2842
MLV	0.6252	0.0739	0.1554	0.33421	0.8007	0.9	1.4053
MHM	0.6252	0.2217	0.0777	0.38054	0.80409	0.9	1.4098
MHL	0.6252	0.2217	0.03885	0.41911	0.80621	0.9	1.368
MHV	0.6252	0.2217	0.1554	0.31373	0.80178	0.9	1.497
MZM	0.6252	0	0.0777	0.41841	0.80287	0.9	1.2822
MZL	0.6252	0	0.03885	0.46081	0.80499	0.9	1.2442
MZV	0.6252	0	0.1554	0.34494	0.80057	0.9	1.3616
LMM	0.4168	0.1478	0.0777	0.47541	0.82713	0.9	1.2384
LML	0.4168	0.1478	0.03885	0.52359	0.82932	0.9	1.2018
LMV	0.4168	0.1478	0.1554	0.39194	0.82476	0.9	1.3151
LLM	0.4168	0.0739	0.0777	0.49068	0.82672	0.9	1.1999
LLL	0.4168	0.0739	0.03885	0.54041	0.8289	0.9	1.1644
LLV	0.4168	0.0739	0.1554	0.40453	0.82435	0.9	1.2742
LHM	0.4168	0.2217	0.0777	0.46061	0.82783	0.9	1.2782
LHL	0.4168	0.2217	0.03885	0.5073	0.83001	0.9	1.2404
LHV	0.4168	0.2217	0.1554	0.37974	0.82546	0.9	1.3574
LZM	0.4168	0	0.0777	0.50644	0.82658	0.9	1.1625
LZL	0.4168	0	0.03885	0.55777	0.82876	0.9	1.1281
LZV	0.4168	0	0.1554	0.41752	0.82421	0.9	1.2345

Table A.1: Fiscal Policy Rule Parameters (1)

Rule	ρ_{ψ}	$\rho_{\psi y}$	$\rho_{\psi d}$	ψ_{min}	ψ_{av}	ψ_{set}	ψ_{max}
HMM	0.74236	0.1478	0.0777	0.35279	0.79274	0.9	1.4432
HML	0.74236	0.1478	0.03885	0.38854	0.79483	0.9	1.4005
HMV	0.74236	0.1478	0.1554	0.29084	0.79046	0.9	1.5326
HLM	0.74236	0.0739	0.0777	0.36412	0.79234	0.9	1.3983
HLL	0.74236	0.0739	0.03885	0.40102	0.79443	0.9	1.3569
HLV	0.74236	0.0739	0.1554	0.30019	0.79006	0.9	1.4849
HHM	0.74236	0.2217	0.0777	0.34181	0.7934	0.9	1.4896
HHL	0.74236	0.2217	0.03885	0.37645	0.7955	0.9	1.4455
HHV	0.74236	0.2217	0.1554	0.28179	0.79113	0.9	1.5818
HZM	0.74236	0	0.0777	0.37582	0.7922	0.9	1.3548
HZL	0.74236	0	0.03885	0.4139	0.79429	0.9	1.3147
HZV	0.74236	0	0.1554	0.30983	0.78993	0.9	1.4387
ZMM	0	0.1478	0.0777	0.69651	0.89512	0.9	1.0181
ZML	0	0.1478	0.03885	0.7671	0.89748	0.9	0.98798
ZMV	0	0.1478	0.1554	0.57422	0.89256	0.9	1.0812
ZLM	0	0.0739	0.0777	0.71888	0.89467	0.9	0.98643
ZLL	0	0.0739	0.03885	0.79175	0.89703	0.9	0.95724
ZLV	0	0.0739	0.1554	0.59266	0.89211	0.9	1.0475
ZHM	0	0.2217	0.0777	0.67483	0.89588	0.9	1.0508
ZHL	0	0.2217	0.03885	0.74323	0.89824	0.9	1.0197
ZHV	0	0.2217	0.1554	0.55635	0.89331	0.9	1.1159
ZZM	0	0	0.0777	0.74198	0.89452	0.9	0.95573
ZZL	0	0	0.03885	0.81718	0.89688	0.9	0.92744
ZZV	0	0	0.1554	0.6117	0.89196	0.9	1.0149

Table A.2: Fiscal Policy Rule Parameters (2)

Appendix B

Event Sequence Classifications

Classification	Description	Summarising
ALLxx	All events	All
BAILA	All bailouts	All bailouts
BAILF	Govt unsuccessfully bails out Household	anything starting with BF**
BAILS	Govt successfully bails out Household	Anything successful
BAILx	Govt bails out Household	
BAILx.BFHDx	Govt bails out Household, Govt attempts and fails bailout, HH defaults	
BAILx.GDEFx	Govt bails out Household, Government defaults	
BAILx.HDGTx	Govt bails out Household, Government refused bailout debt greater than limit	
BAILx.HDLTx	Govt bails out Household, Government refused bailout debt less than limit	
BFGDA	All events starting with a failed bailout attempt, government default	All Household and govt default together
BFHDA	All events starting with a failed bailout attempt, household default	Only some failed with a Household default
BFHDx	Govt Attempts and fails bailout, HH defaults	
BFHDx.BFGDx	Govt Attempts and fails bailout, HH defaults, HH causes Govt to default after failed bailout	
BFHDx.GDEFx	Govt Attempts and fails bailout, HH defaults, Government defaults	

Table B.1: Event Sequence Classification (1)

B.1 Scenario Event Counts

Classification	Description	Summarising
GDEFA	All events starting with a government default	All government initiated sequences
GDEFx	Government defaults	
GDEFx.BAILx	Government defaults, Govt bails out Household	
GDEFx.BFHDx	Government defaults, Govt Attempts and fails bailout, HH defaults	
GDEFx.GDHDx	Government defaults, Govt default causes HH default	
GDEFx.HDGTx	Government defaults, Government refused bailout debt greater than limit	
GDEFx.HDLTx	Government defaults, Government refused bailout debt less than limit	
GDEFx.HDNBx	Government defaults, Government does not bailout	
HDGDA	All events starting with a household defaulting followed by government defaulting in same period	
HDGTA	Government refused bailout debt greater than limit	All failed bailouts where public debt was above the limit
HDGTx	Government refused bailout debt greater than limit	
HDGTx.BAILx	Government refused bailout debt greater than limit, Govt bails out Household	
HDGTx.GDEFx	Government refused bailout debt greater than limit, Government defaults	
HDGTx.HD~GD	Government refused bailout debt greater than limit, Government forced to default, because HH defaulted first as government limited bailout	

Table B.2: Event Sequence Classification

Classification	Description	Summarising
HDLTA	Government refused bailout debt less than limit	All failed bailouts where public debt was below the limit
HDLTx	Government refused bailout debt less than limit	
HDLTx.BAILx	Government refused bailout debt less than limit, Govt bails out Household	
HDLTx.BFHDx	Government refused bailout debt less than limit, Govt attempts and fails bailout, HH defaults	
HDLTx.GDEFx	Government refused bailout debt less than limit, Government defaults	
HDNBA	All events starting with a No bailout	Where government has a policy of not bailing out
HDNBx	Government does not bailout	
HDNBx.GDEFx	Government does not bailout, Government defaults	
HDNBx.HD~GD	Government does not bailout, Government forced to default, because HH defaulted first as government limited bailout	

Table B.3: Event Sequence Classification

Event	MMM HCDL ALB FW EXP	MMM HCLL ALB FW EXP	MMM HCPS ALB FW EXP	MMM HCLL NOB FW EXP	MMM HCLL ASB FW EXP	MMM HCPS ASB FW EXP	MMM HCLL BSB FW EXP	MHV HCPS ALB FW EXP	MHV HCPS ASB FW EXP	HHL HCLL NOB FW EXP	HHV HCDL ALB FW EXP	HHV HCLL ALB FW EXP	HHV HCDL NOB FW EXP	HHV HCLL NOB FW EXP	HZL HCLL NOB FW EXP	ZHV HCLL NOB FW EXP
ALLxx	28034	37491	30704	36815	37108	30489	37171	30421	30261	62781	37750	54074	37175	54094	25202	27860
BAILA	21034	23794	22573	0	4782	4044	19114	23355	7076	0	21899	4943	0	0	0	0
BAILF	1111	1737	1242	0	1494	1084	394	1747	1444	0	3459	802	0	0	0	0
BAILx	19923	22057	21331	0	3288	2960	18720	21608	5632	0	18440	4141	0	0	0	0
BAILx.BFHDx	34	58	42	0	49	38	0	53	37	0	155	46	0	0	0	0
BAILx.GDEFx	1077	1679	1200	0	1442	1041	78	1694	1403	0	3304	756	0	0	0	0
BAILx.HDGTx	0	0	0	0	0	0	316	0	0	0	0	0	0	0	0	0
BAILx.HDLTx	0	0	0	0	3	5	0	0	4	0	0	0	0	0	0	0
BFHDA	123	249	144	0	258	155	0	147	134	0	399	631	0	0	0	0
BFHDx	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0
BFHDx.BFGDx	96	204	117	0	212	121	0	112	103	0	338	608	0	0	0	0
BFHDx.GDEFx	27	45	27	0	46	34	0	35	31	0	59	20	0	0	0	0
GDEFA	6877	13448	7987	12939	13217	7882	13148	6919	6917	40483	15452	48500	15005	48549	999	3826
GDEFx	6329	12819	5788	12311	12594	5709	12514	6187	6183	36810	10952	224	10619	215	977	3602
GDEFx.BAILx	75	404	70	0	4	70	401	132	132	0	280	111	0	0	0	0
GDEFx.BFHDx	353	0	563	0	0	544	0	416	422	0	369	131	0	0	0	0
GDEFx.GDHDx	120	225	1566	230	228	1559	230	184	180	2534	3851	48034	3766	48089	7	18
GDEFx.HDGTx	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
GDEFx.HDLTx	0	0	0	0	391	0	0	0	0	0	0	0	0	0	0	0
GDEFx.HDNBx	0	0	0	398	0	0	0	0	0	1139	0	0	620	245	15	206

Table B.4: Frequency of Events (1a)

Event	MMM HCDL ALB FW EXP	MMM HCLL ALB FW EXP	MMM HCPS ALB FW EXP	MMM HCLL NOB FW EXP	MMM HCLL ASB FW EXP	MMM HCPS ASB FW EXP	MMM HCLL BSB FW EXP	MHV HCPS ALB FW EXP	MHV HCPS ASB FW EXP	HHL HCLL NOB FW EXP	HHV HCDL ALB FW EXP	HHV HCLL ALB FW EXP	HHV HCDL NOB FW EXP	HHV HCLL NOB FW EXP	HZL HCLL NOB FW EXP	ZHV HCLL NOB FW EXP
HDGTA	0	0	0	0	0	0	4909	0	0	0	0	0	0	0	0	0
HDGTx	0	0	0	0	0	0	3154	0	0	0	0	0	0	0	0	0
HDGTx.BAILx	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
HDGTx.GDEFx	0	0	0	0	0	0	1545	0	0	0	0	0	0	0	0	0
HDGTx.HD~GD	0	0	0	0	0	0	207	0	0	0	0	0	0	0	0	0
HDLTA	0	0	0	0	18851	18408	0	0	16134	0	0	0	0	0	0	0
HDLTx	0	0	0	0	18615	18232	0	0	15809	0	0	0	0	0	0	0
HDLTx.BAILx	0	0	0	0	133	127	0	0	207	0	0	0	0	0	0	0
HDLTx.BFHDx	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
HDLTx.GDEFx	0	0	0	0	103	49	0	0	113	0	0	0	0	0	0	0
HDNBA	0	0	0	23876	0	0	0	0	0	22298	0	0	22170	5545	24203	24034
HDNBx	0	0	0	21949	0	0	0	0	0	17191	0	0	18350	4129	24114	23414
HDNBx.GDEFx	0	0	0	1714	0	0	0	0	0	4438	0	0	3441	800	81	570
HDNBx.HD~GD	0	0	0	213	0	0	0	0	0	669	0	0	379	616	8	50

Table B.5: Frequency of Events (1b)

Event	ZZL HCDL ALB FW EXP	ZZL HCLL ALB FW EXP	ZZL HCDL NOB FW EXP	ZZL HCLL NOB FW EXP	ZZV HCLL NOB FW EXP	MMM HCPS ALB RW EXP	MMM HCPS ASB RW EXP	MHV HCPS ALB RW EXP	MHV HCPS ASB RW EXP	MMM HCLL ALB FW SOC	MMM HCLL ALB FW CON	MMM HCLL ALB FW AUS	MMM HCLL ALB FW EAU	MMM HCLL NOB FW AUS	MMM HCLL NOB FW SOC	MMM HCDL NOB FW EXP
ALLxx	23879	24484	23753	24290	24715	30704	30489	30421	30261	124,940	224,600	194,680	349,990	193,090	123,340	27734
BAILA	23592	24188	0	0	0	22573	4044	23355	7076	18817	13660	13496	5795	0	0	0
BAILF	27	28	0	0	0	1242	1084	1747	1444	8964	10449	8749	5795	0	0	0
BAILx	23565	24160	0	0	0	21331	2960	21608	5632	9853	3211	4747	0	0	0	0
BAILx.BFHDx	1	1	0	0	0	42	38	53	37	373	351	308	278	0	0	0
BAILx.GDEFx	26	27	0	0	0	1200	1041	1694	1403	8591	10098	8441	5517	0	0	0
BAILx.HDGTx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BAILx.HDLTx	0	0	0	0	0	0	5	0	4	0	0	0	0	0	0	0
BFHDA	2	2	0	0	0	144	155	147	134	2053	2980	2266	3197	0	0	0
BFHDx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFHDx.BFGDx	2	2	0	0	0	117	121	112	103	1825	2829	2032	3007	0	0	0
BFHDx.GDEFx	0	0	0	0	0	27	34	35	31	228	151	234	190	0	0	0

Table B.6: Frequency of Events (2a)

Event	ZZL HCDL ALB FW EXP	ZZL HCLL ALB FW EXP	ZZL HCDL NOB FW EXP	ZZL HCLL NOB FW EXP	ZZV HCLL NOB FW EXP	MMM HCPS ALB RW EXP	MMM HCPS ASB RW EXP	MHV HCPS ALB RW EXP	MHV HCPS ASB RW EXP	MMM HCLL ALB FW SOC	MMM HCLL ALB FW CON	MMM HCLL ALB FW AUS	MMM HCLL ALB FW EAU	MMM HCLL NOB FW AUS	MMM HCLL NOB FW SOC	MMM HCDL NOB FW EXP
HDGTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HDGTx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HDGTx.BAILx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HDGTx.GDEFx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HDGTx.HD~GD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HDLTA	0	0	0	0	0	0	18408	0	16134	0	0	0	0	0	0	0
HDLTx	0	0	0	0	0	0	18232	0	15809	0	0	0	0	0	0	0
HDLTx.BAILx	0	0	0	0	0	0	127	0	207	0	0	0	0	0	0	0
HDLTx.BFHDx	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
HDLTx.GDEFx	0	0	0	0	0	0	49	0	113	0	0	0	0	0	0	0
HDNBA	0	0	23489	24017	24360	0	0	0	0	0	0	0	0	15585	20711	21096
HDNBx	0	0	23468	23996	24327	0	0	0	0	0	0	0	0	3808	9082	19882
HDNBx.GDEFx	0	0	20	20	27	0	0	0	0	0	0	0	0	9748	9755	1115
HDNBx.HD~GD	0	0	1	1	6	0	0	0	0	0	0	0	0	2029	1874	99

Table B.7: Frequency of Events (2b)

B.2 Summary of Events (Graphs)

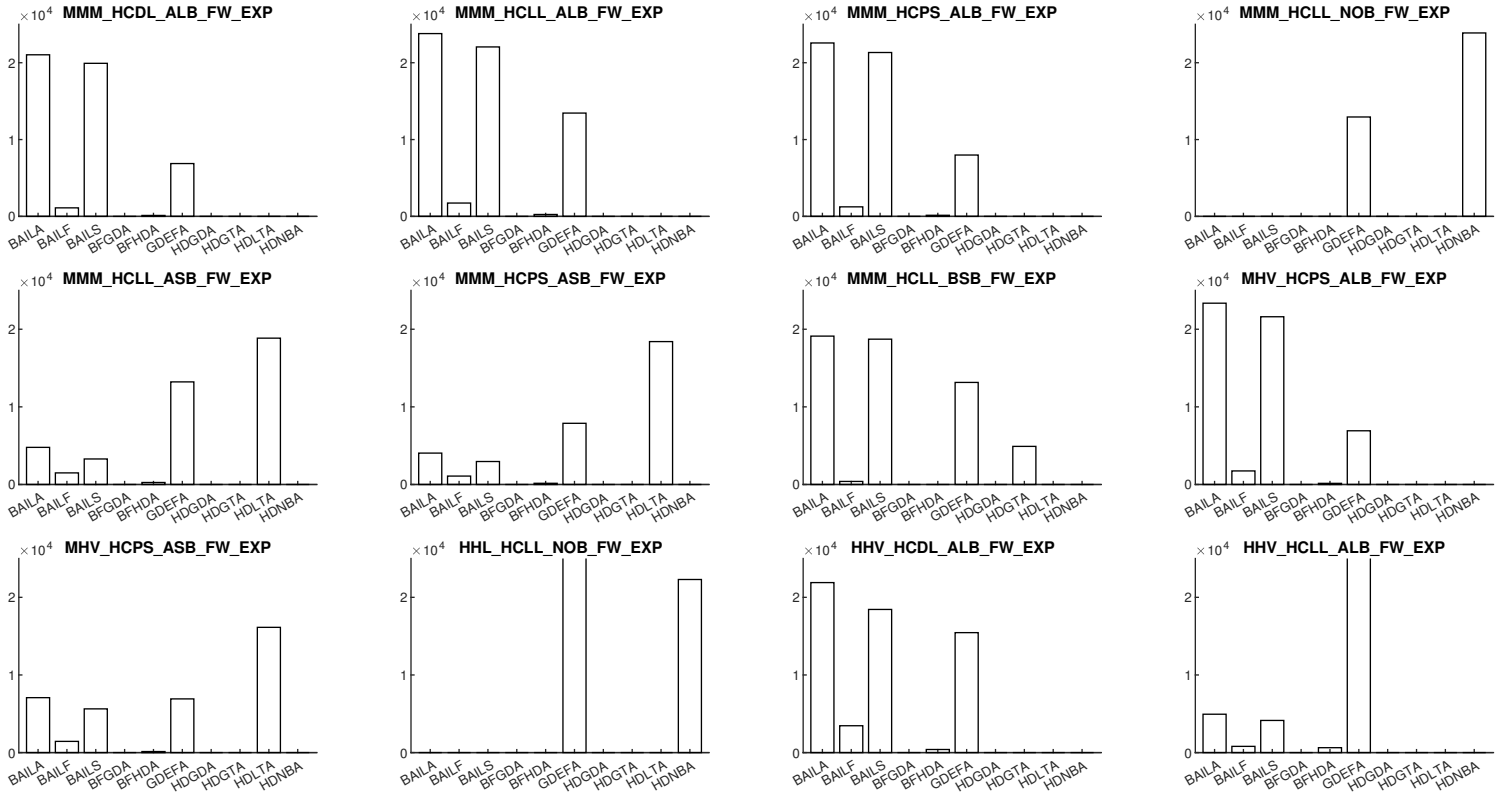

Figure B.1: Summary sequence events by scenario

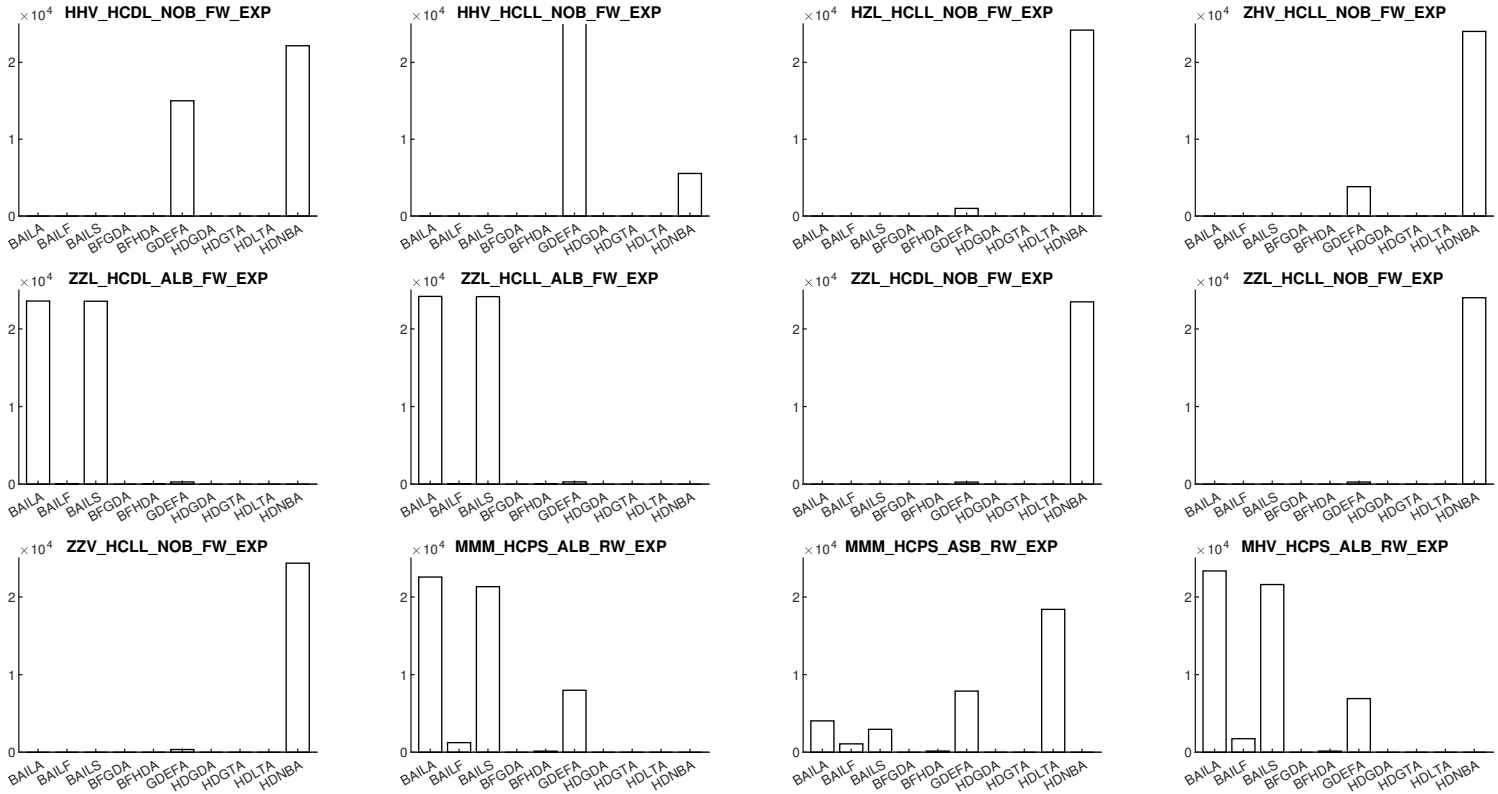

Figure B.2: contd., Summary sequence events by scenario

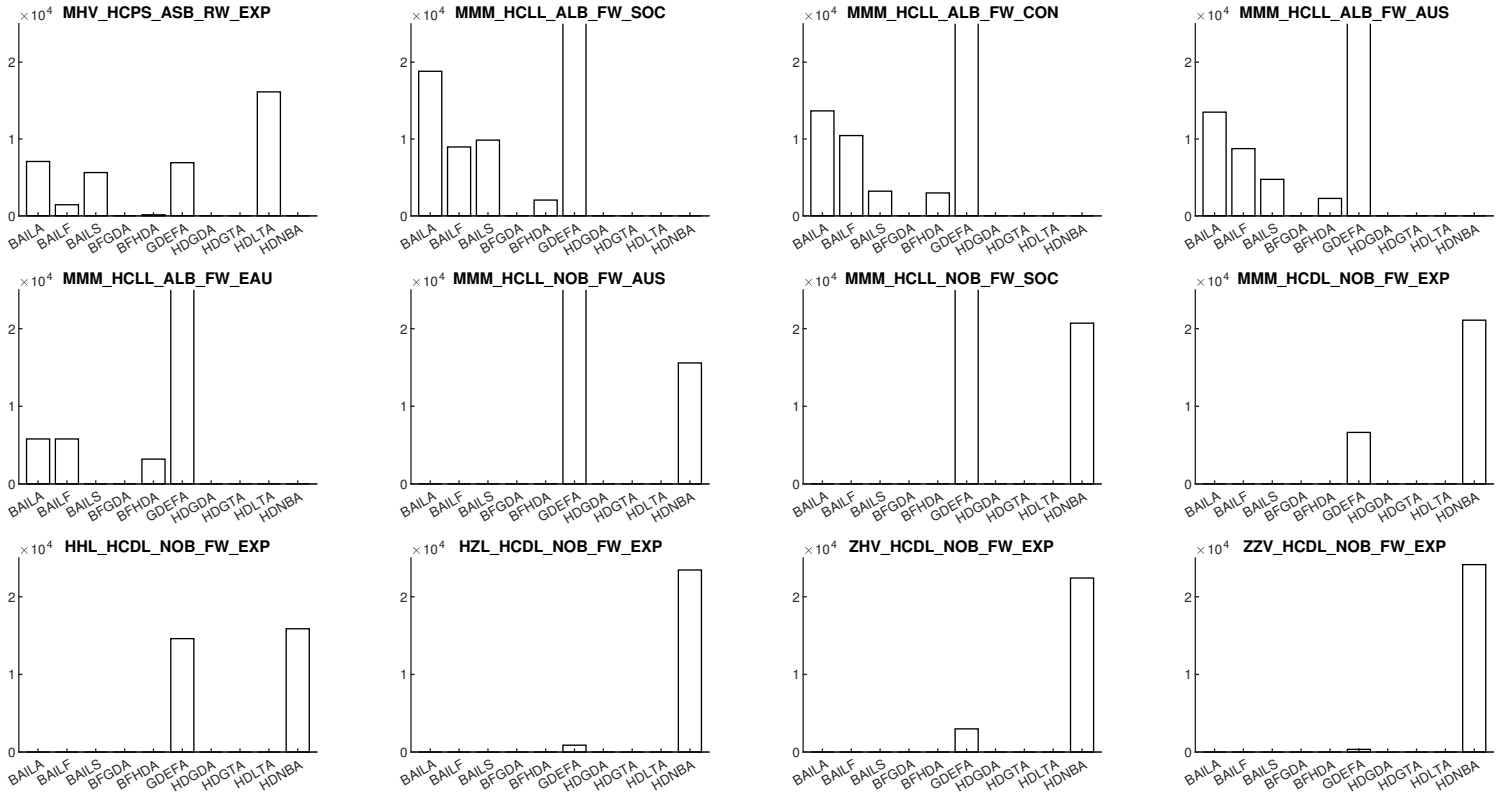

Figure B.3: contd., Summary sequence events by scenario